Almond Pest Management Alliance

Year 2 Report

Contract number: 98-0326

Contract title: **"To Promote a Reduced-Risk System of Almond Production Through Alternative Practices"**

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Date: Dec. 31, 2000

Prepared for California Department of Pesticide Regulation

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This report was submitted in fulfillment of DPR contract number 98-0326 "To Promote A Reduced System of Almond Production Through Alternative Practices" by the Almond Board of California under the (partial) sponsorship of the California Department of Pesticide Regulation. Work was completed as of July 31, 2000.

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Executive Summary

The Almond Pest Management Alliance (PMA) was initiated by the Almond Board of California and formed in 1998 to evaluate the possibility of managing economic pests by implementing reduced risk pesticides. Working closely with the Almond Hullers and Processors Association, the Community Alliance with Family Farmers, the University of California Statewide IPM Project, and University of California Cooperative Extension, an alliance was formed to study reduced risk practices in California almonds. This collaborative approach grew out of two major concerns: The implementation of the Food Quality Protection Act (FQPA) of 1996 with possible loss of some traditional crop protection tools, and growing public concern over water quality standards in the San Joaquin River and Sacramento River watersheds, with possible links to pesticides used by almond growers.

The Almond Board of California initiated discussions among various industry stakeholders to look at the possibility of forming a cooperative effort to pursue a grant available from the California Department of Pesticide Regulation. Those industry stakeholders include the Almond Board of California, the Almond Hullers and Processors Association, the Community Alliance with Family Farmers, the University of California Statewide IPM Project, and University of California Cooperative Extension (UCCE) almond farm advisors. The PMA project is now in its third year of reduced risk implementation, thereby demonstrating a commitment by the Almond industry, the University, and by the almond growers.

Because of the enormous scope of the California almond industry which encompasses approximately 585,000 acres, ranging from Bakersfield to Red Bluff, and the wide range of pests and regional variables, the PMA continues to rely on three regional projects. These projects are located in the Northern Sacramento Valley (Butte County), the Central San Joaquin Valley (Stanislaus County) and the Southern San Joaquin Valley (Kern County). Each project consists of an orchard that is divided into a conventional practice treatment and a reduced risk treatment. There are variations to the reduced risk practice with various degrees of reduced risk practices. Each project is directed by the local UCCE farm advisor who establishes the plot and best addresses local pest concerns and growing conditions that would be relevant to the local growers. The advisors employ a field scout who performs the extensive monitoring required.

The target pests addressed across all three projects continue to be navel orangeworm (NOW), peach twig borer (PTB), San Jose scale, mites, and ants. Diseases, cover crops, and fertilizer applications are studied on a regional basis. Smaller satellite projects compliment the PMA orchard demonstration sites by providing research about regional issues.

Other aspects of the dynamic Almond PMA are frequent communications among the Advisory team, analysis of pesticide use reports, outreach and extension of the most current information through meetings and mailings, and project evaluation.

Overall, we can conclude that the extension of information and outreach to growers is critical to adopting reduced risk practices. The University of California involvement is paramount to ensure scientific credibility is being employed throughout the project. The success of the PMA project essentially rests on the proactive growers who are willing to be innovative and take risks in order to give reduced risk practices validity. Finally, we can conclude that we are building a foundation of pest information that may result in a better understanding of economic pests.

Future improvements of the Almond PMA are to:

1. Increase monitoring through the dormant season,
2. Incorporate an unsprayed control treatment into each orchard, and
3. Implement smaller, more frequent, more regionally based field meetings regarding reduced risk practices.

In conclusion, the second year of Almond PMA demonstrated the following:

- Reduced risk practices appear to be controlling the pests below economic damage levels.
- Extensive orchard monitoring is key to the success of this approach.
- Other pest populations begin to build as a result of altering spray programs.
- Growers in the Almond PMA have made an unselfish commitment to continue to study reduced risk programs by remaining in the PMA for a continuous third year
- Almond growers are interested in reduced risk practices and continue to be proactive in adopting these practices.
- A commitment for multiyear funding is needed to obtain scientifically valid data on which growers and PCA's can make sound economic and environmental decisions regarding reduced risk programs.

Almond Pest Management Alliance Final Report

INTRODUCTION

The Almond Pest Management Alliance (PMA) was funded by a $98,976 grant awarded by the California Department of Pesticide Regulation (CDPR) for the crop year Aug. 1, 19989to July 31, 200. The proposal is titled "To Promote a Reduced-Risk System of Almond Production Through Alternative Practices. This report is the product of the second year funding. A third year of funding was awarded for the crop year Aug. 1, 2000 to July 31, 2001.

The Almond Board of California, the Almond Hullers and Processors Association, the Community Alliance with Family Farmers, the University of California Statewide IPM Project, and University of California Cooperative Extension (UCCE) almond farm advisors are members of the Almond PMA.

Structurally, the Almond PMA is managed by a team composed of representatives from each of the identified organizations, as well as a private Pest Control Advisor (PCA.) The team meets on a quarterly basis to review the progress and make decisions about its future course. The administrative functions are overseen by the Almond Board of California.

The Almond PMA established the following basic objectives in Year One and they continue to be relevant through subsequent years of funding.

- Establish orchard sites in three different almond-growing regions to collect data regarding almond pest management practices that reduce risks associated with pesticide use.
- Conduct extensive orchard monitoring and specific research activities that address localized pest control and almond production practices.
- Provide almond growers with updated information on available reduced risk pest control practices so they can make informed choices about alternatives.
- Promote and extend information to growers to ensure California almond growers understand the need for a reduced risk system that has the ability to reduce pesticides and sustain profitability.

- Evaluate the risk reduction achieved as a result of this project by producing a final report that includes not only a projection of the risk reduced, but a discussion of the costs and benefits of the solution and the practicality of adoption.

The implementation of the federal Food Quality Protection Act of 1996 (FQPA) and the increased public and regulatory concerns regarding water quality in the San Joaquin River and Sacramento River watersheds were the catalysts for the formation of the Almond PMA. The project objectives to successfully deal with these issues were decided upon by the Almond PMA advisory team. In order to successfully fulfill these objectives, the PMA team has formed a positive relationship with the growers involved, remains abreast of farming techniques, researches pesticide use trends, maintains interest by extending information by field meetings and newsletter, and finally, draws conclusions in reports.

To complement the objectives involved in the Almond PMA, tasks were designed to accomplish the goal of reducing pesticide use.

- Task 1 is to assemble an Advisory team that meets and keep the project moving forward.
- Tasks 2 through Task 4 consist of the individual orchards in each region – Butte, Stanislaus and Kern county.
- Task 5 is to research pesticide use in each of the regional PMA sites.
- Outreach and education to the growers comprise Task 6. Task 6 is the accumulation of field meetings, newsletters, and news articles relating to the Almond PMA.
- Task 7 is the project evaluation.

The target pests addressed across all three regional projects continue to be navel orangeworm (NOW), peach twig borer (PTB,) San Jose scale, mites and ants. These pests, in general, pose the greatest economic challenge to California almond growers.

The PMA is an efficient way to practically implement many years of research on alternative and reduced risk management techniques, and to demonstrate their effectiveness and costs as they relate to more conventional pest management practices. By applying the vast body of knowledge accumulated over the years by the University of California the Alliance's goal is to study and demonstrate reduced risk practices on a large scale in regional settings.

The Almond Board of California has been supporting an Integrated Pest Management (IPM) system for more than 25 years. During the 1997-98 crop year, the Almond Board funded ten IPM projects for a total of $190,270. These projects have helped reduce the use of pesticides through such studies as: Navel orangeworm Orchard Sanitation and Early Harvest, Reducing Dormant Spray Hazards, Pheromones for Peach twig borer, and Alternatives for Soil Fumigation with Methyl Bromide. Results of these research projects are available from the Almond Board of California. The Board has also received an "IPM Innovator Award" from CDPR for its innovative leadership role in the field of IPM.

The UC Statewide IPM Project is well recognized for its national leadership on IPM. The IPM Project publishes the well-respected *IPM for Almonds Manual.* This publication states, "A good IPM program coordinates pest management activities with cultural operations to achieve economical and long-lasting solutions to pest problems." The Almond PMA is an important program to implement reduced risk farming practices and find cultural and long-lasting solutions for almond growers.

Reduced risk strategies such as CAFF's Biologically Integrated Orchard Systems (BIOS) program seek to demonstrate that a small, but growing number of almond producers have been successfully reducing their insecticide, herbicide, and fertilizer inputs without affecting yield or quality. Most program growers have experience with individual components of the system, such as Bt sprays and insect releases. By combining these with seeded cover crops, modified mowers, increased monitoring, and habitat enhancement, BIOS growers have replaced the broad-spectrum chemical control on their farms with biological processes and selective insecticides.

RESULTS

Task 1:

Task 1 is the formation, cooperation, and planning by the Advisory Team. The Advisory Team is responsible for implementing and designing new ways to approach reduced risk practices. Communication is key and the results from this task have been very successful. The PMA Advisory Team conducted three meetings. The first meeting was held in March, the second held in June, and the third in September. These timely meetings provide a forum for discussion of issues, concerns, successes, and overall updates of the Almond PMA. Field meetings and presentation topics are discussed. Suggestions for improvements to the project are discussed. The Advisory Team is essential for the success of the Almond PMA by providing leadership, direction, and expertise.

The Advisory Team held three meetings and one conference call meeting. The meetings were held on March 14, June 14, and September 7. The conference call involving Carolyn Pickel, Mark Looker, Chris Heintz, and Nicole Darby occurred on February 4. These meetings are the building blocks on which the PMA program operates. 4

Task 2 – 4:

The Almond PMA is designed to be a demonstration project, with grower-cooperators in three regional areas. In these orchards, the data collected can enable the almond growing community to witness a reduced risk system in action. With the information provided by the Alliance, growers and their Pest Control Advisors (PCA's) can see first-hand the monitoring techniques, the economics, the yields, the practices used and even talk with the grower himself about how the project works. It is not feasible to directly compare the numbers and results of each individual orchard. Due to differences in farming practices, pest pressures, and treatments, directly comparing the figures may lead to incorrect conclusions. In addition to the information regarding each of the three regional orchards, there will be a pesticide use summary for those three regions. Each will be specific and show organophosphate, carbamate, pyrethroid, and Bt use for each county.

Task 2:

Butte County

22 acres

Orchard Specifications

This orchard is approximately 49 acres. The grower standard block is 27 acres, the PMA block is 22 acres divided into a 12-acre soft treatment, a 5-acre dormant organophosphate spray, and a 5 acre dormant and hullsplit organophosphate spray. Traps were placed in the center Nonpareil row on the north side of the same tree and monitored weekly.

Peach Twig Borer

Peach twig borer traps were placed in the Butte County Pest Management Alliance orchard on March 22, 2000. One trap was placed in each of the four blocks: grower standard, soft chemical, dormant spray, and dormant-hullsplit spray. Traps were monitored weekly, lures changed every two weeks, and liners changed as necessary. The first biofix occurred on April 4, 2000. Subsequent biofix dates are: July 5, August 3, and September 19. Figure 2.1 demonstrates the peach twig borer generations and Table 2.1 shows seasonal total trap counts.

Table 2.1. Butte Co. Seasonal peach twig borer trap captures as of10/5/00.

	Grower Standard	**Soft**	**Dormant OP**	**Dormant + Hullsplit OP**
Peach twig borer	3017	2711	2394	2280

Peach twig borer shoot strikes were counted on 5/16/00 by inspecting 20 vigorous shoots on six random trees per treatment. No PTB strikes were noted. Shoot strikes were monitored systematically again on 5/23/00 and only 2 PTB shoot strikes were noted on the inspected trees.

Navel orangeworm

Mummy counts on 20 randomly chosen trees in each block were taken in January 2000. An average of these 80 trees indicated there were 3.3 mummy nuts per tree in the orchard. Since this number was too high for navel orangeworm IPM, winter sanitation was indicated. Heavy wind and rain occurred in February and March and another similar mummy count was performed on March 6, 2000. Following the late winter winds and rain, the number of mummy nuts in the entire orchard was less than one per tree. Winter sanitation, either natural or imposed, is the most effective means of controlling navel orangeworm.

Navel orangeworm traps were placed in trees on April 25, 2000. The biofix for this orchard occurred on April 25, 2000. The second biofix occurred on 6/29, the third biofix occurred on 8/5, and the last biofix occurred on 8/23. Figure 2.2 demonstrates the relatively low numbers of navel orangeworm eggs found of the egg traps as well as the degree-days depicting generations and Table 2.2 shows seasonal totals of navel orangeworm. Overall, there were very few eggs detected on our traps in the orchard. Low populations of navel orangeworm are attributed to winter sanitation.

Table 2.2. Seasonal total of NOW eggs Butte Co. PMA 2000

	Grower Standard	Soft	Dormant OP	Dormant + Hullsplit OP
Navel orangeworm eggs	30	4	45	8

San jose scale and san jose scale parasite

Dormant 100 spur samples were taken in December 1999 from each of the four blocks and evaluated for san jose scale. These dormant spur samples indicated that less than 10% had scale or parasitized scale in each block. San jose scale traps were placed in the orchard on March 17, 2000. New traps were placed in the tree weekly as the old traps were collected, wrapped in plastic wrap, and brought back to the laboratory to be evaluated under a microscope. The male scale and the parasites were counted using the random blocks provided on each trap. The first biofix for San jose scale was on 3/27, approximately three weeks earlier than in 1999, and populations grew until April 10, 2000. After this date, the male scale reappeared sporadically in low numbers on 5/10, 6/20, and 7/11. Parasites were present starting on 3/27. These numbers grew through 4/10 and then dropped significantly. When male scale was detected on the traps, the parasite was most often detected as well. Season totals show that the grower standard block had the most male scale and the least number of parasites. The dormant-hullsplit block had the least scale but had many parasites present with 8285 total (Table 2.3).

Table 2.3. Butte Co. Seasonal total of San jose scale males and parasites trapped 2000.

	Grower Standard	**Soft**	**Dormant OP**	**Dormant-Hullsplit OP**
San jose scale	595	495	555	375
Prospaltella	3405	4575	11035	8285

Mites

In 1999, 50% of dormant spurs had European red mite (ERM) eggs present. This year's dormant sample showed a much lower percent of spurs with ERM eggs. Seventeen percent of the grower standard spurs, eighteen percent in the PMA, eight percent of the dormant organophosphate sprayed spurs, and eight percent of the organophosphate dormant and hullsplit treatment had detectable ERM eggs.

Mite monitoring for two spotted mites began on June 1, 2000 and continued weekly until August 16, 2000. At each sampling, five trees per block were chosen randomly and fifteen leaves from each of the five were collected and inspected for red mites, two-spot mites, beneficial mites, and beneficial insects. Differentiation between two-spot mites and red mites were not noted. The total season count shows that the grower standard block had the least mites and the highest number of beneficial insects/predatory mites observed (Table 2.4). There was an increase of mites and their predators on 8/8/00 and the orchard was monitored again on 8/11. However, on 8/11/00, harvest had begun and a mite treatment could not be applied. Since the population increase occurred late in the season, and defoliation was minimal, these mites will not be detrimental to tree performance next year.

Table 2.4. Butte Co. Seasonal total of leaves with predator mites/beneficial insects and European/two-spot mites 2000.

	Grower Standard	**Soft**	**Dormant OP**	**Dormant + Hullsplit OP**
Predators / Beneficials	33	17	14	6
Mites	26	101	74	44

Ants

Ant traps were placed in each block in the orchard on 8/8/00. Baited with dried almonds collected from the orchard, weekly monitoring detected no ant activity.

European fruit lecanium

European fruit lecanium, *Lecanium corni*, populations have been building in this orchard. The scale was not detected in the first year of the project, but a population was first detected during the dormant spur sample inspection at the beginning of the second year. European fruit lecanium (EFL) was on 8% of the dormant spurs in the grower standard and in 15% of the spurs in the PMA soft treatments. Populations were not detected in the two treatments receiving a dormant spray, the organophosphate dormant treatment and the organophosphate dormant and hullsplit treatment. No monitoring protocol exists but a satellite project studying in-season oil sprays for the control of EFL was conducted in Butte County and the results are pending.

Diseases

(shothole, scab, anthracnose)

Diseases were monitored by visual inspection and there were no major disease outbreaks throughout the orchard this year.

Harvest

Harvest samples were collected from Nonpareil trees in the trap row on August16, 2000. Five trees from each treatment were chosen and 100 almonds per tree totaling 500 almonds per block were collected. Almonds were cracked out and inspected for peach twig borer, navel orangeworm, oriental fruit moth, and ant damage. The almonds were first inspected for hull damage and then meats further inspected for damage. Hulls were inspected for OFM and PTB damage but not differentiated unless a larva was detected. The meats were inspected for PTB, OFM, NOW, and ant damage. Hull damage observed is expressed in percent in Table 2.5 and kernel damage in Table 2.6. Quality was outstanding in all four blocks this year.

Table2.5. Hull feeding noted in the Butte Co. Almond PMA site 2000.

	Grower Standard	Soft	Dormant	Dormant + Hullsplit
PTB/OFM	3.6%	2.2%	2.8%	1.6%
OFM Larva	0.4%	0	0	0.2%
PTB Larva	0	0	0	0

Table 2.6. Kernel quality (% damage) from the Butte Co. Almond PMA site 2000.

	Grower Standard	Soft	Dormant	Dormant + Hullsplit
PTB	0.8%	0.2%	0.6%	0

NOW	0	0.8%	0	0.4%
OFM	0	0	0	0
Ant	0.4%	1.6%	0.4%	1%

Economic Data 2000

In Table 2.7 below, the materials and costs for running each of the four treatment programs are calculated and recorded. The grower standard with three sprays is the most economical. The next most economical treatment is the PMA soft treatment that had two total applications but Rally was applied for shothole whereas the grower standard applied Rovral for shothole. The application of Rally increased the treatment cost per acre. However, the least economical treatments were those treatments receiving the organophosphate applications. The dormant organophosphate treatment received three total applications of material at a cost of $119.67 per acre. The organophosphate dormant and hullsplit treatment received four total applications which cost $161.72 per acre.

Table 2.7. Economic data for Butte County Almond PMA 2000.

Grower's Standard

Practice	Material	Rate/Acre	Cost/Acre	Application Cost/Acre	Total Cost/Acre
2/21 - 2/28					
Brown Rot	Vanguard	4.04 oz.	$11.72	$18.00	**$29.72**
3/13					
Shot-Hole	Rovral	2.38 oz.	$5.78		
PTB	Condor	6.1 oz	$2.63		
			$8.41	$18.00	**$26.41**
					$56.13

PMA Soft Approach

Practice	Material	Rate/Acre	Cost/Acre	Application Cost/Acre	Total Cost/Acre

2/21 - 2/28 Brown Rot	Vanguard	4.04 oz.	$11.72	$18.00	**$29.72**
3/13 Shothole PTB	Rally Condor	4 lbs. 6.1 oz.	$17.40 $2.63 **$20.03**	$18.00	**$38.03**
					$67.75

Dormant Spray Comparison

Practice	Material	Rate/Acre	Cost/Acre	Application Cost/Acre	Total Cost/Acre
1/28 OP Dorm	Diazinon	4 pints	$15.28		
	Kocide	10 lbs.	$20.70		
	Oil	4.8 gal	$12.19		
			$48.17	$18.00	**$66.17**
2/21 - 2/28 Brown Rot 3/13	Vanguard	4.04 oz.	$11.72	$18.00	**$29.72**
Shothole	Rovral	2.38 oz.	$5.78	$18.00	**$23.78**
					$119.67

Dormant Spray + Hullsplit Spray Comparison

Practice	Material	Rate/Acre	Cost/Acre	Application Cost/Acre	Total Cost/Acre
1/28 OP Dorm	Diazinon	4 pints	$15.28		

	Kocide	10 lbs.	$20.70		
	Oil	4.8 gal	$12.19		
			$48.17	$18.00	**$66.17**
2/21 - 2/28					
Brown Rot	Vanguard	4.04 oz.	$11.72	$18.00	**$29.72**
3/13					
Shothole	Rovral	2.38 oz.	$5.78	$18.00	**$23.78**
7/15					
OP Hullsplit	Kinetic	1 qt.	$9.15		
	Lorsban	4 pints	$14.90		
			$24.05	$18.00	**$42.05**
					$161.72

Listed below are the costs for orchard floor management which is the same across all four treatments and the nitrogen costs which are also the same across all four treatments.

Orchard Floor Management (same on all plots)

Practice	Material & Rate/ac	Material Cost/ac	Application Cost/ac	Total Cost/acre
2/4 Strip Spray	Rup@22 oz.	$5.92		
	Goal@1oz.	$1.53	$3.28	$10.73
2/27 Chop Solid				$3.94
4/12 Chop Alternate				$2.42
5/1 Chop Alternate				$2.82

5/15 Strip Spray	Rup@10 oz.	$3.29		
	2,4-D@4.5oz.	$1.08	$3.28	$7.05
5/19 Chop Alternate				$3.23
5/30 Chop Alternate				$2.62
6/22 Chop Alternate				$2.42
7/15 Solid Spray	Rup@23.27oz.	$6.26	$3.28	$9.54
7/30 Chop Solid				$4.84
8/9 Solid Spray	Rup@30.38oz.	$8.17	$3.28	$11.45
				$61.06

Nitrogen Nutrition (same on all plots)

Practice	**Material & Rate/ac**	**Material Cost/ac**	**Application Cost/ac**	**Total Cost/acre**
Late April, water run UN-32	51.71 lbs N	$14.71		$14.71
NO3-N in 2.1 Ac-Ft. Well Irrigation	22.5 lbs. N	0		0
Total	**74.2 Lbs. N**			**$14.71**

Comparison of 1999 and 2000 Results from Butte County

The Almond Pest Management Alliance has just completed the second year of studying reduced risk techniques. Whereas no statistical information is drawn, a direct comparison between the two seasons is noted. In most instances, there was an increase in the total seasonal pest numbers but not in the harvest damage. Table 2.8 through Table 2.13 show the comparisons between the first two years of the Almond PMA.

Table 2.8 Butte Co. Seasonal totals: peach twig borer counts for 1999 and 2000.

	Grower Std	**PMA**	**OP Dorm**	**OP Dorm + Hullsplit**
1999	1344	1664	1163	1031
2000	3017	2711	2394	2280

Table2.9 Butte Co. Seasonal totals: male san jose scale counts for 1999 and 2000.

	Grower Std	**PMA**	**OP Dorm**	**OP Dorm + Hullsplit**
1999	45	205	320	85
2000	595	495	555	375

Table 2.10 Butte Co. Seasonal totals: *Prospaltella sp.* counts for 1999 and 2000.

	Grower Std	**PMA**	**OP Dorm**	**OP Dorm +**

				Hullsplit
1999	1990	2385	2355	3335
2000	3405	4575	11035	8285

Table 2.11 Butte Co. Seasonal totals: navel orangeworm counts from 1999 and 2000.

	Grower Std	PMA	OP Dorm	OP Dorm + Hullsplit
1999	28	34	30	29
2000	30	4	45	8

Table 2.12 Butte Co. Seasonal totals: number of leaves with European red mites or web spinning mites in 1999 and 2000.

	Grower Std	PMA	OP Dorm	OP Dorm + Hullsplit
1999	9	12	34	26
2000	26	101	74	44

The economic comparisons and the amount of spray applications are noted below in Table 2.13.

Table 2.13. Butte County application and cost comparison 1999 and 2000 Almond PMA.

	1999		2000	
	Application	Cost/Acre	Application	Cost/Acre
Grower Std	4	$100.35	2	$56.13
PMA	3	$67.65	2	$67.75
OP Dorm	3	$85.49	3	$119.67
OP Dorm + HS	4	$110.61	4	$161.72

Conclusion

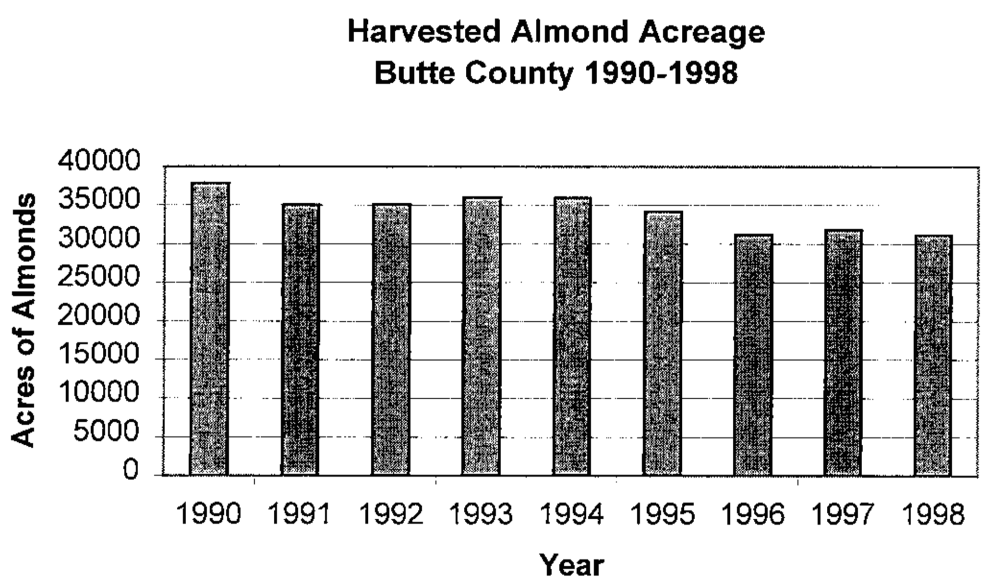
It was another successful season with the Butte County Almond Pest Management Alliance. The spring meeting was well attended and interest in adopting reduced risk practices remains in the forefront for growers. The project was able to monitor using the same techniques as the first year, thus helping to ensure that the effects of reduced risk practices are being documented. The key to successful reduced risk practices is intensive monitoring. The project will continue to monitor to ensure that the potential for economic damage is minimized.

The Almond PMA has been active for two years in Butte County. Interest in reduced risk farming practices has increased as the economic viability of the methods has been demonstrated. The PMA has been beneficial for growers, industry, and the environmental and regulatory community.

Butte County Pesticide Summary

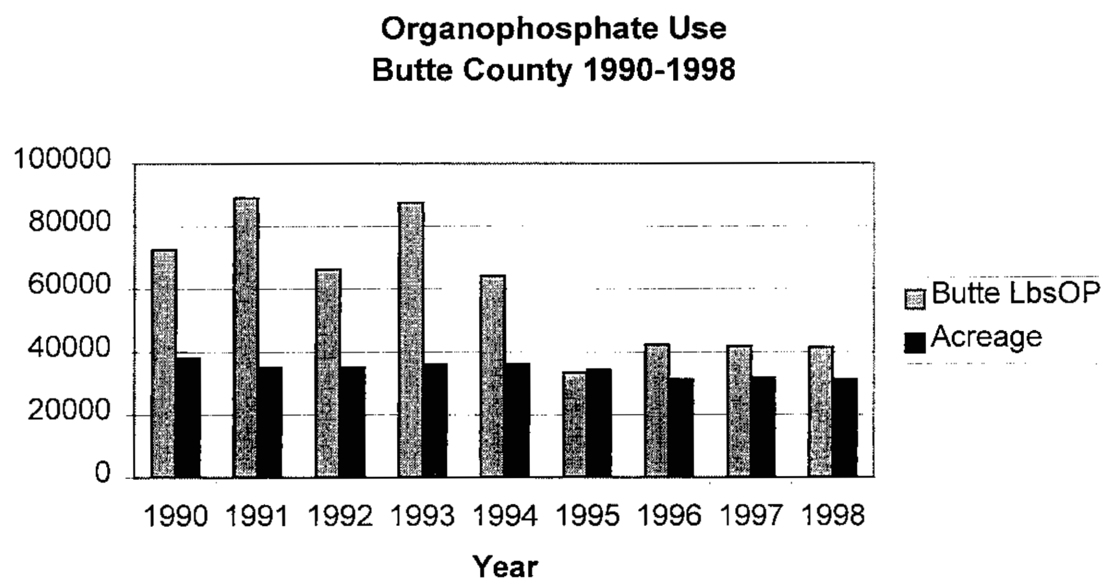
Butte County almond acreage has remained relatively stable over the past nine years. This trend is seen in Chart 2.1. The information regarding harvested acreage was accessed via the World Wide Web at the California Agricultural Statistical Service (CASS). All pesticide use information was accessed via the World Wide Web on www.ipm.ucdavis.edu and the California Department of Pesticide Regulation, www.cdpr.gov.

Chart 2.1. Harvested Almond Acreage in Butte County 1990-1998.



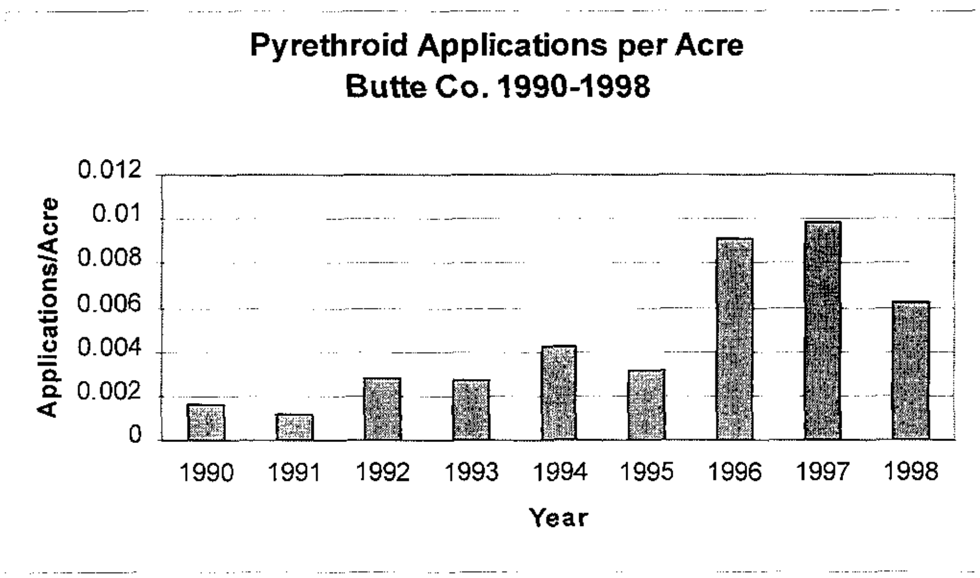
Organophosphate use in Butte County compared to almond acreage in Butte County is noted in Chart 2.2 below. There has been substantial proactive drive to limit the amount of organophosphates in Butte County. Organophosphates used in this calculation are azinphos-methyl, diazinon, chlorpyrifos, methidathion, parathion, naled, phosmidion, and phosmet.

Chart 2.2. Organophosphate use in Butte County from 1990-1998.



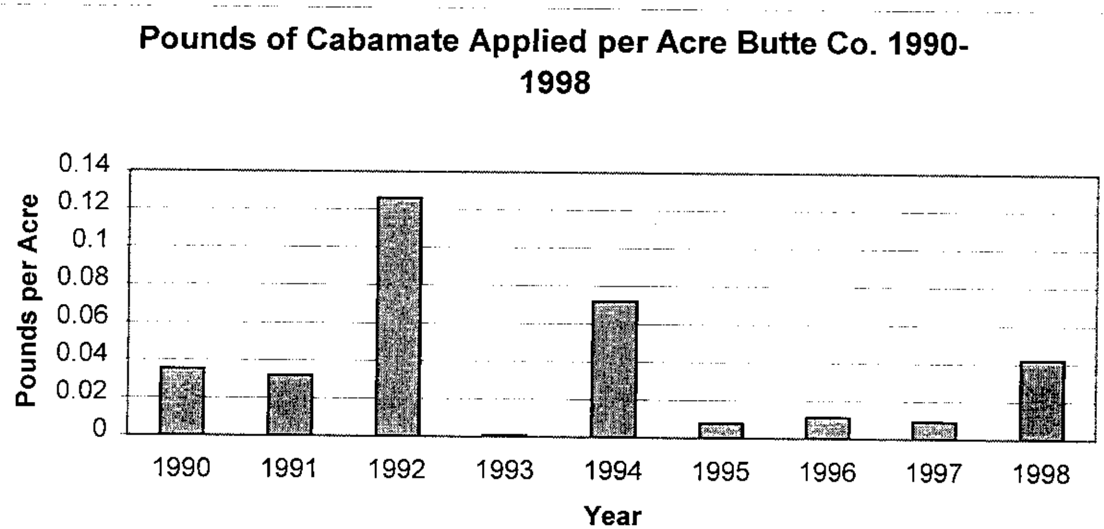
Pyrethroid use in Butte County shows an increase in use throughout 1990-1998. The trend of pyrethroid use is noted in Chart 2.3. Pyrethroids compiled for this report were esfenvalerate, permethrin, and pyrethrin.

Chart 2.3. Pyrethroid applications per acre in Butte County 1990-1998.



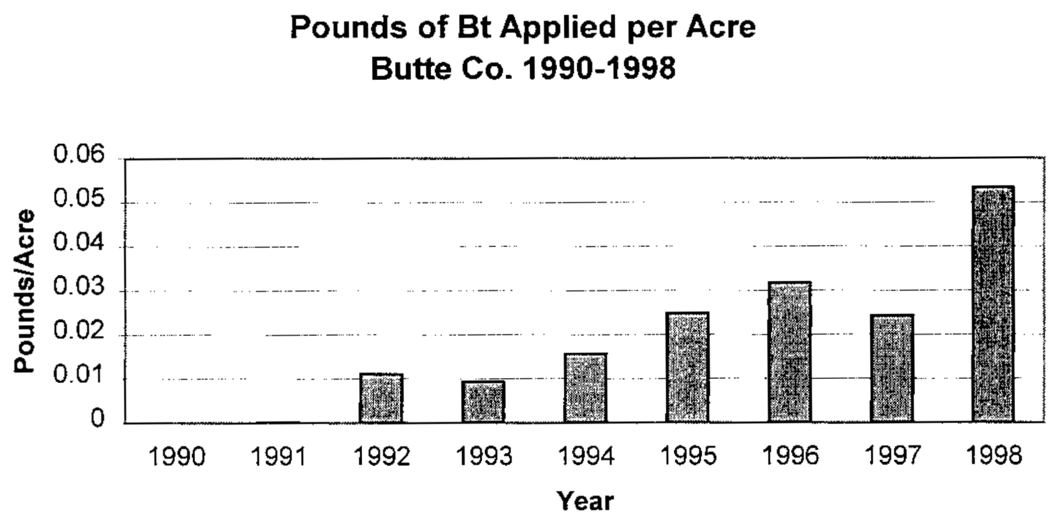
Carbamate use in Butte County from 1990-1998 is noted in Chart 2.4. Carbamates compiled for this chart were carbaryl and methomyl. In 1993, only 22 pounds of carbamates were applied in Butte County. However, there has been a steady decrease in the amount of carbamates applied per acre since 1994.

Chart 2.4. Pounds of Carbamates applied per acre in Butte County 1990-1998.



The use of Baccilus thurigiensis (Bt) has grown considerable over the past nine years. For this report all strains of Bt were used. The amount of pounds applied to almonds in Butte County are noted in Chart 2.5. In 1990 and 1991, virtually no Bt was applied to Butte County almonds, however, in 1998, over 1,500 pounds were applied which shows an increase in use from 1992 to 1998.

Chart 2.5. Pounds of Bt applied per acre in Butte County Almonds 1990-1998.



Overall, Butte County harvested acreage has remained steady yet pounds of organophosphates and carbamates has dropped or remained relatively low. The number of applications of pyrethroids rose slightly then has dropped down in 1998. However, the pounds of Bt applied have risen steadily, which is a positive trend.

Fig. 1: Peach twig borer Trap Counts
Almond PMA Butte Co. 2000

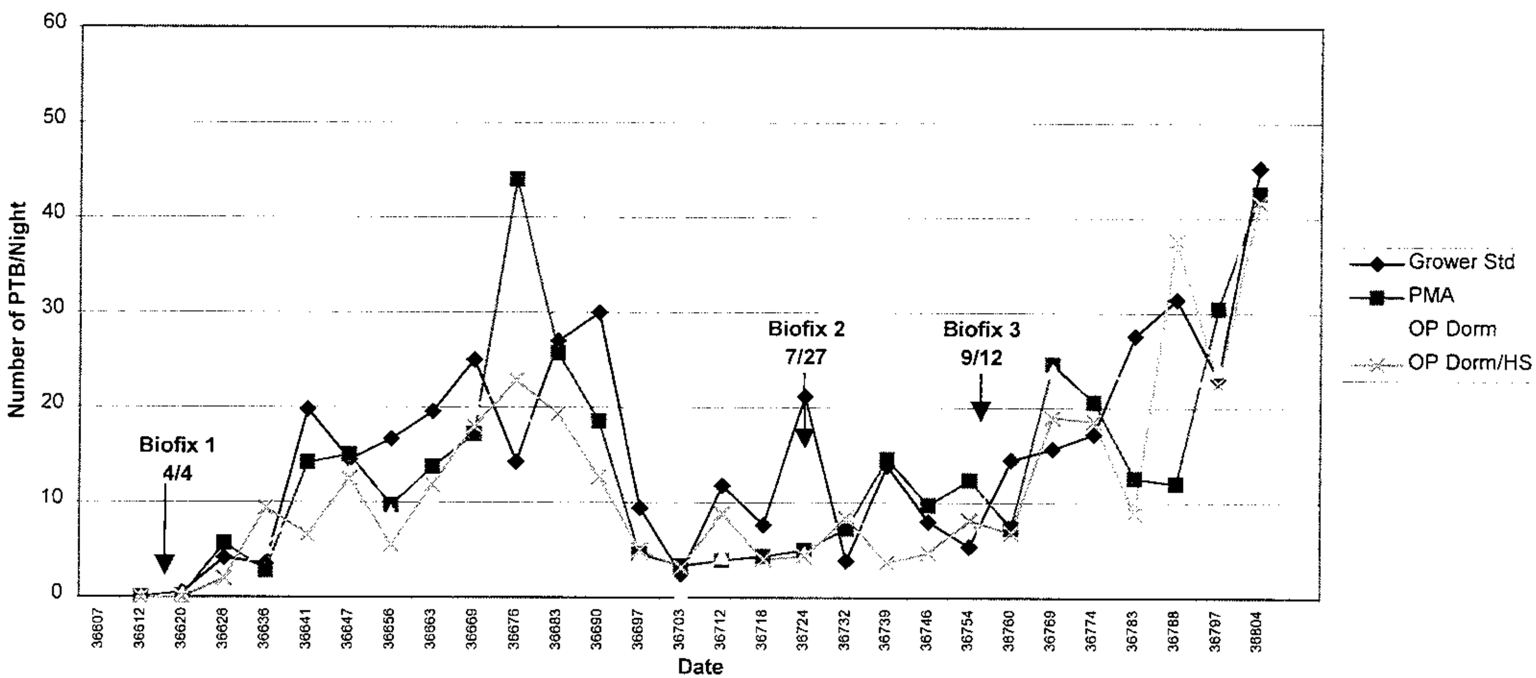
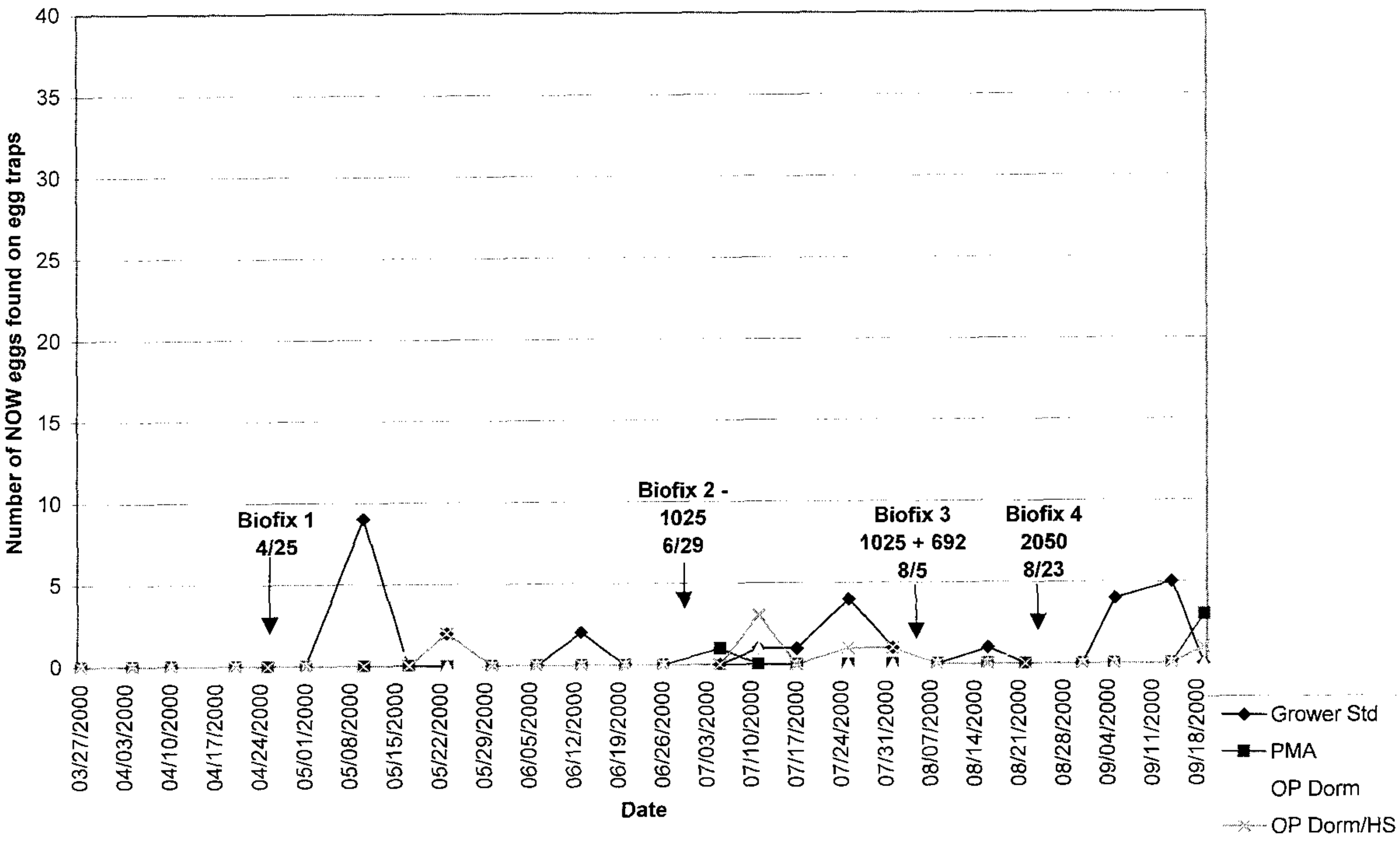


Fig. 2: Navel orangeworm egg Trap Counts
Almond PMA Butte Co. 2000



Task 3:

Kern County

Introduction:

The purpose of this project was to demonstrate a reduced pesticide input versus a conventional pesticide program in young almond orchards. The comparison between the two programs is found in Appendix A. It has the comparison of 1999 and 2000.

An individual site was found with two, 40-acre blocks of "hard" shell varieties (Butte, Mission and Padre) and two, 40-acre blocks of "soft" shells (Nonpareils, Sonora and Fritz). Each 40-acre block was divided into reduced input and conventional programs. This gave us two replications in both "hard" and "soft" shell varieties. The demonstration was started in November, 1998 with the planting of a cover crop and has continued until the present time.

Cover Crop:

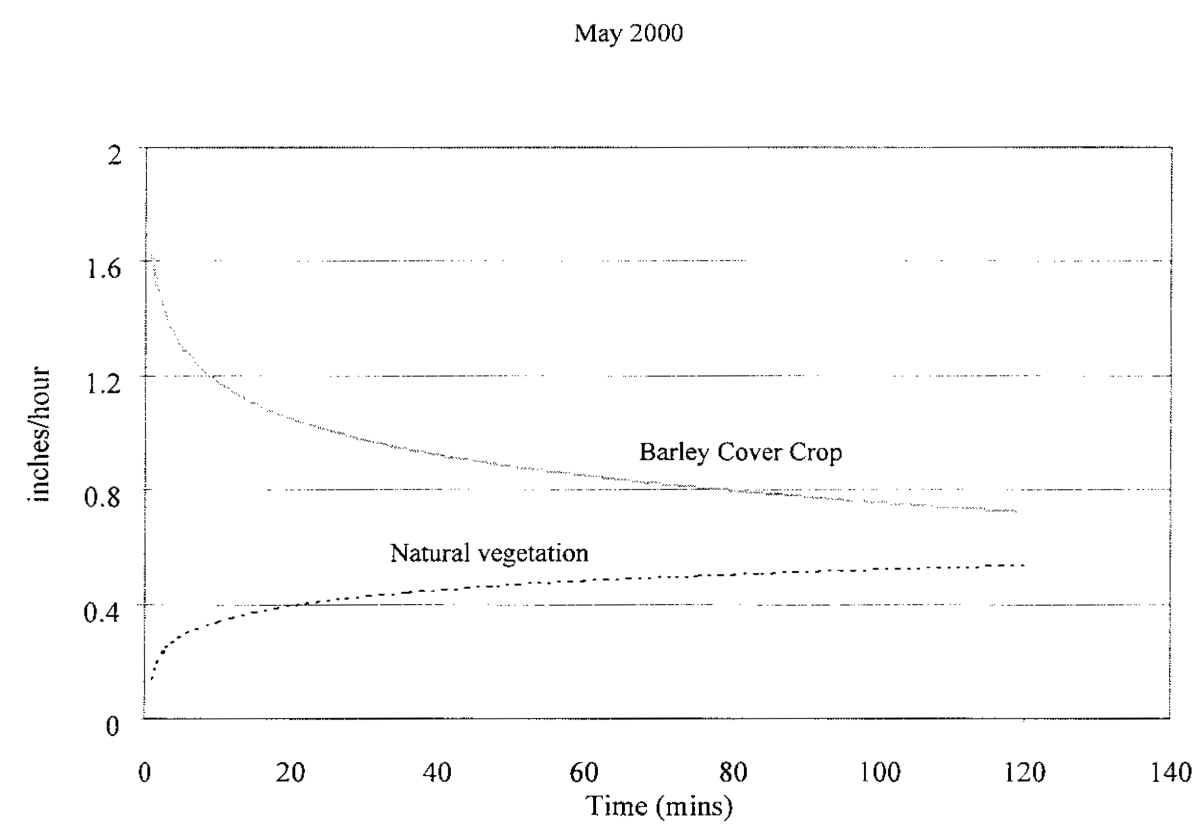
Barley was selected as the cover crop because of the saline-alkali and poor drainage conditions of the soil. The barley was seeded in every middle on both "soft" and "hard" shell blocks at a rate of 40 lbs. per acre. This was done in November of 1998 and 1999. Also, at the same time, an insectary was established in every 11th middle using the "Bios Insectary Mix" at a seeding rate of 10 lbs. per acre. This insectary mix will not be planted in November of 2000. The reason being that it was difficult to establish in 1998 and 1999. Furthermore, the "insectary mix" didn't increase predator insects that controlled key pests.

The barley germinated well in 1998 due to winter rains. The result was a solid cover in the middles. In 1999, there was poor winter rains and the barley didn't germinate well, but it did still make a good cover in the middles.

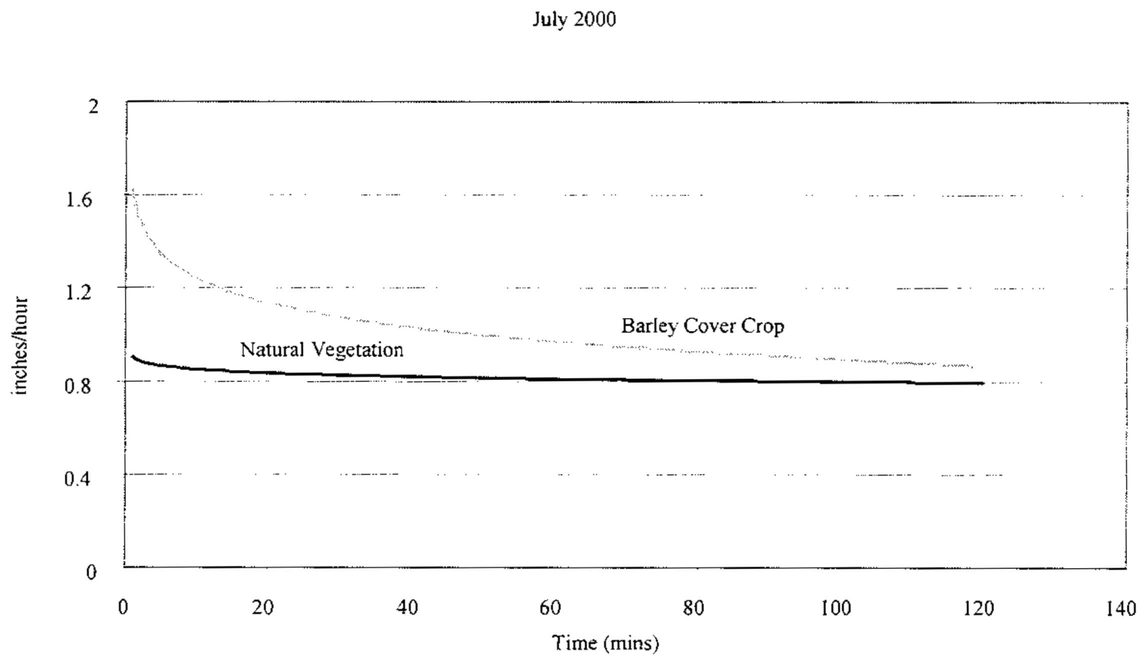
The "Bios Insectary Mix" was planted in 1998 and in 1999. Appendix B shows the composition of both mixes. The germination of both mixes was poor. There were good amounts of rain fall in 1998, but not in 1999, however, the germination was poor in both years. The clovers, rye, vetch, coriander, and celery failed to germinate in 1998 and only a few plants of toothpick weed and yarrow were present in this year. The germination was not any better in 1999. The insectary seed was planted within the wet zone of the mini-sprinkler. There, some clovers, toothpick weed, California poppy, yarrow, baby blue eyes and sweet alyssum germinated in the middles. The amount of insectary plants was not plentiful enough to create a thick cover. Nevertheless, it did provide a habitat for ladybug insects.

One of the benefits of the barley cover crop was on water infiltration rates. The water infiltration rate was greater where barley was planted than the natural vegetation in May, July, and October. The differences in the rate of infiltration can be seen in Graphs 1, 2, and 3.

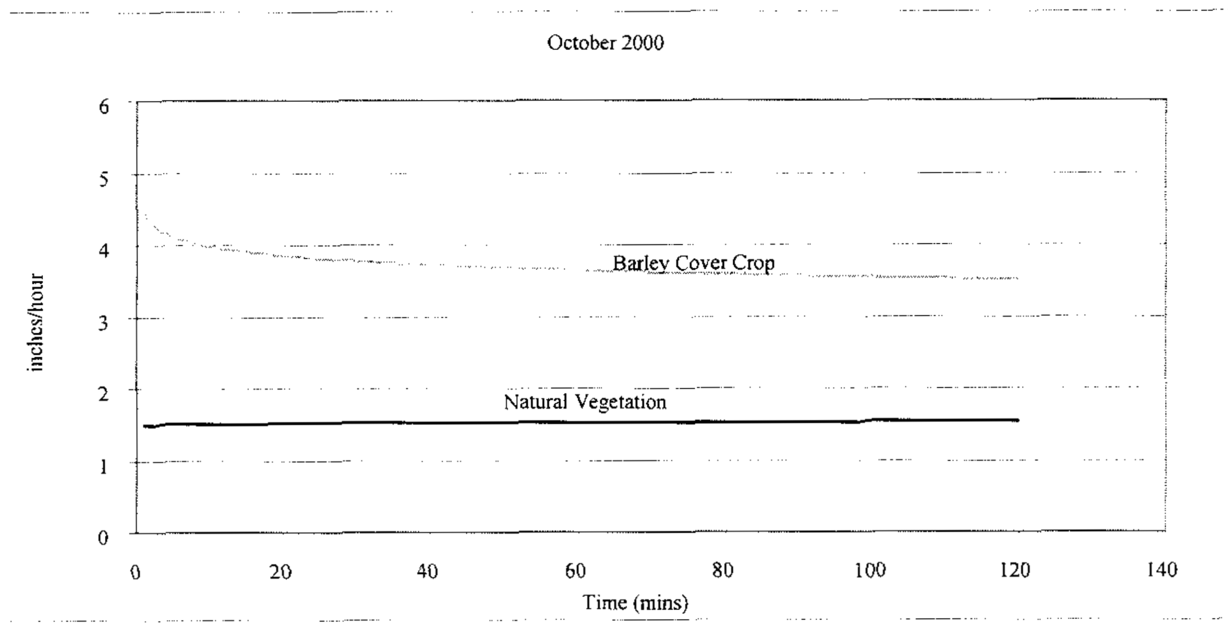
Graph 1. Kern Co. Rate of infiltration (inches/hour) in barley and natural vegetation cover crops in orchard middles during May.



Graph 2. Kern Co. Rate of infiltration (inches/hour) in barley and natural vegetation cover crop orchard middles during July.



Graph 3. Kern Co. Rates of infiltration (inches/hour) in barley and natural vegetation cover crop orchard middles during October.



Pest Monitoring

Trapping for three key pests of almonds was done throughout the season. Traps were hung together on the same tree, seven trees in from the end of the row in Nonpareil and Mission varieties. Three San Jose Scale sticky traps were placed per block, six to seven feet high in the northeast quadrant of the tree on February 22, 1999. In 2000, only two sticky San Jose traps were placed per block. Traps were placed on March 24th. In both years, the traps were monitored weekly until the end of November. Pheromone lures were replaced every four weeks. Adult San Jose Scale moths were counted, as well as the *Encarsia* and *Aphytis* adults. Double-sided sticky tapes were placed one per tree in each of the four trees surrounding the "trap tree" on April 15, 1999, and were collected and replaced every other week through November. The number of San Jose Scale crawlers per tape were then counted and recorded. Two peach twig borer traps were placed per block, six to seven feet high in the northeast quadrant of the tree on March 22, 1999.

The same number of traps, in the same location and at the same height, were placed on March 23, 2000. Adult moths were counted weekly until the end of November. Pheromone lures were replaced every eight weeks. Two navel orangeworm traps per block containing an almond meal mixture were placed six to seven feet high in the north side of the tree on March 29, 1999. In 2000, following the same procedure, navel orangeworm traps were placed March 31st. Eggs laid on the exterior grooves of the trap were counted weekly through the end of November. Bait was replaced every eight to ten weeks.

Dormant Spray

The dormant spray of 1999 consisted of five pints of Diazinon® and six gallons of oil in 200 gallons of water per acre. The spray date was January 4th. This was the conventional dormant spray program. The reduced input was left unsprayed. The dormant spray program for the 2000 season was changed to the following: The conventional program consisted of three pints of Lorsban, four gallons of oil and 230 gallons of water per acre and the reduced input received six gallons of oil and 230 gallons per acre. The reason for the change in the dormant spray program in the conventional program was due to a dry and low chilling year. Common beliefs tell us that oil phytotoxicities can occur during a dry and poor chilling year. The reason the reduced input was sprayed with 6 gallons of oil was to prevent the buildup of San Jose Scale. Please note, there was no phytotoxicity due to oil in these treatments.

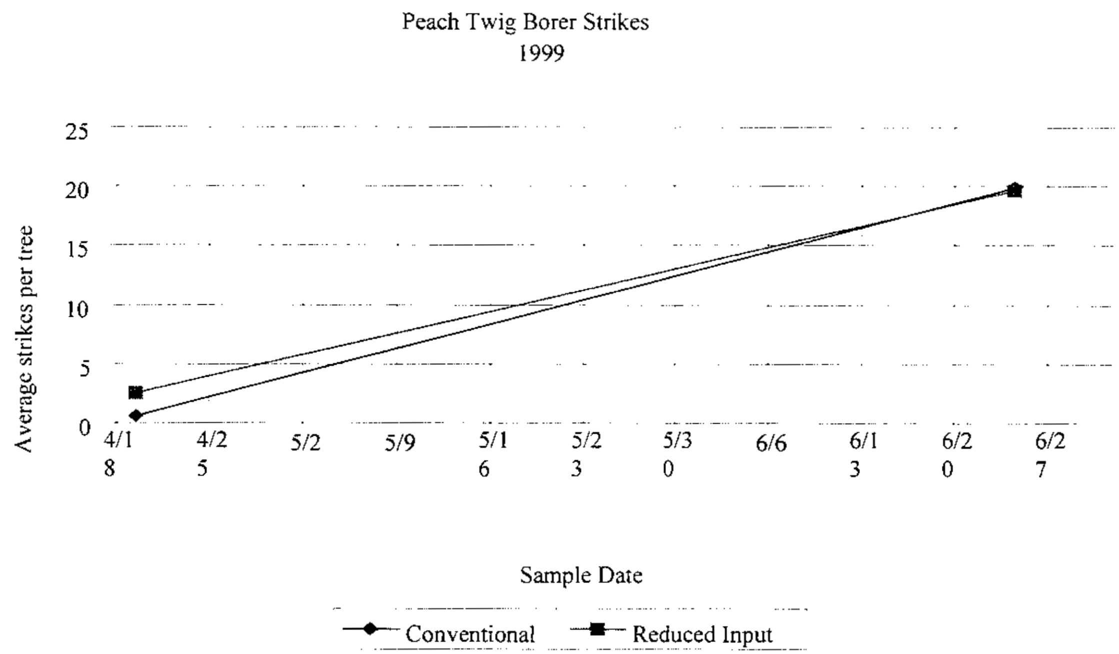
The dormant spray program has given us mixed results for key pests in the PMA orchard. Table 1 shows that PTB emergence was not affected by the dormant spray in 1999. Both conventional and reduced input shows similar amounts of emergence. Based on this information, one can question the value of dormant spray for the control of PTB. In the year 2000, we were unable to evaluate the dormant spray on PTB emergence. The reason, there was no hibernacula in the conventional or in the reduced input treatments.

Table 1. Kern Co. Percent of PTB emergence from samples taken at different dates from reduced input and conventional treated blocks.

Date	Reduced Input	Conventional	Overall
February 15	15%	9%	12%
February 19	18%	27%	22%
February 26	23%	24%	23%
March 5	50%	55%	52%
March 12	77%	75%	76%
March 19	85%	88%	86%

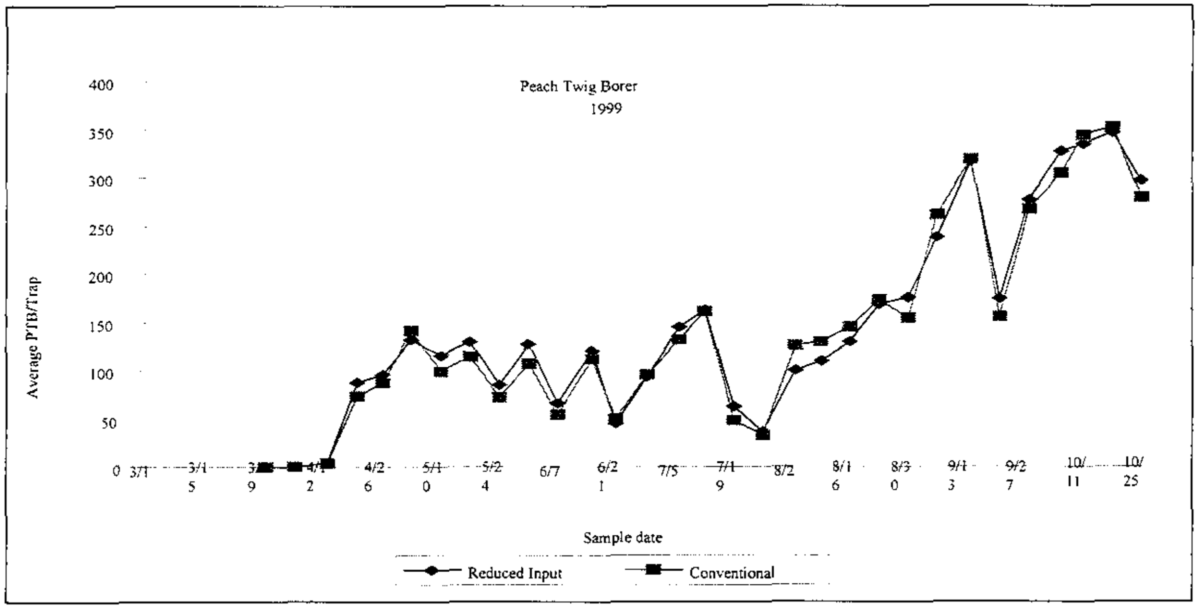
Dormant sprays are also evaluated on the number of PTB shoot strikes in the spring. In the 1999 season, (Graph 4) dormant sprays had little effect in reducing the number of strikes. In fact, both dormant and non-dormant treatments show similar counts in April and same amounts in June.

Graph 4. Kern Co. The average number of strikes per tree on April 19 and June 30 in both reduced input and conventional spray programs.



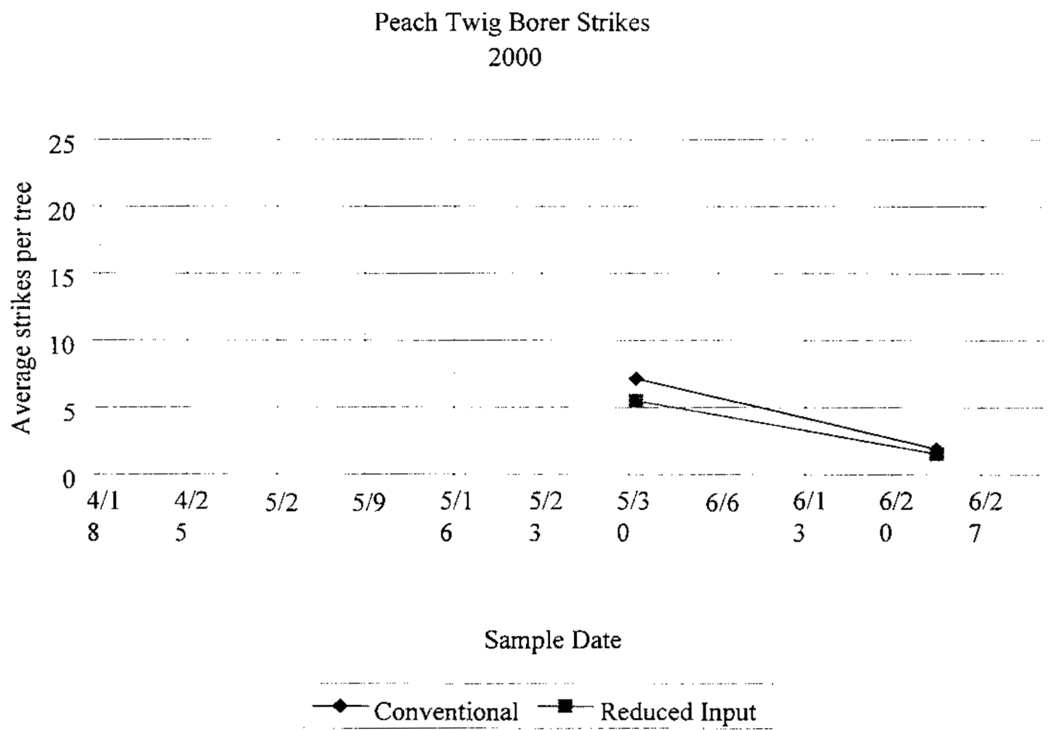
Furthermore, Graph 5 shows that PTB adult population in the 1999 season was not affected by the dormant spray. Both conventional and reduced input had similar numbers through the 1999 growing season.

Graph 5. Kern Co. The average number of PTB adults per trap during the 1999 season in both reduced input and conventional spray programs.



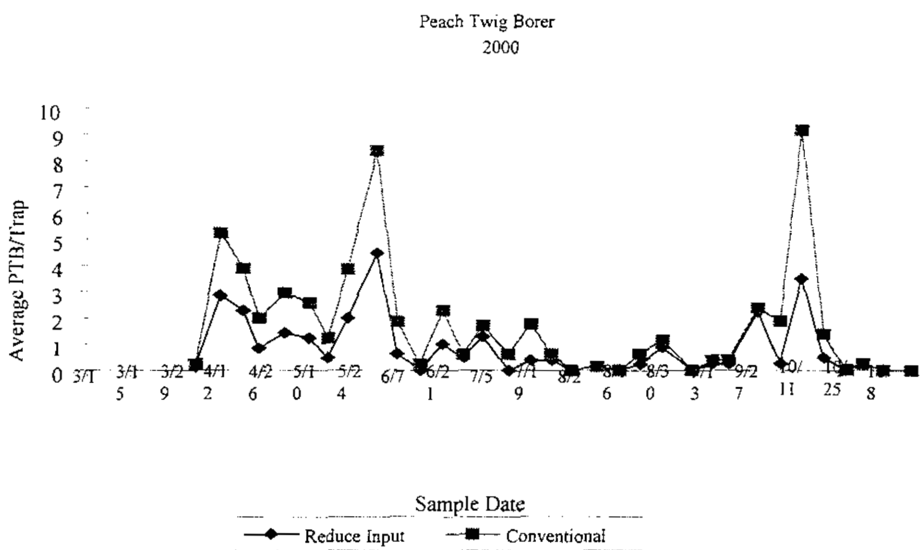
In the 2000 season, (Graph 6) the number of shoot strikes per tree were lower than in the 1999 season. Also, the number of strikes per tree was higher early in the season and decreased at the end of the season. Furthermore, based on the number of strikes per trees from both conventional and reduced input, one can conclude that the dormant spray in 2000 didn't decrease the strikes per tree in the PMA orchard.

Graph 6. Kern Co. The average number of strikes per tree on May 30 and June 25 in both conventional and reduced input dormant spray programs.



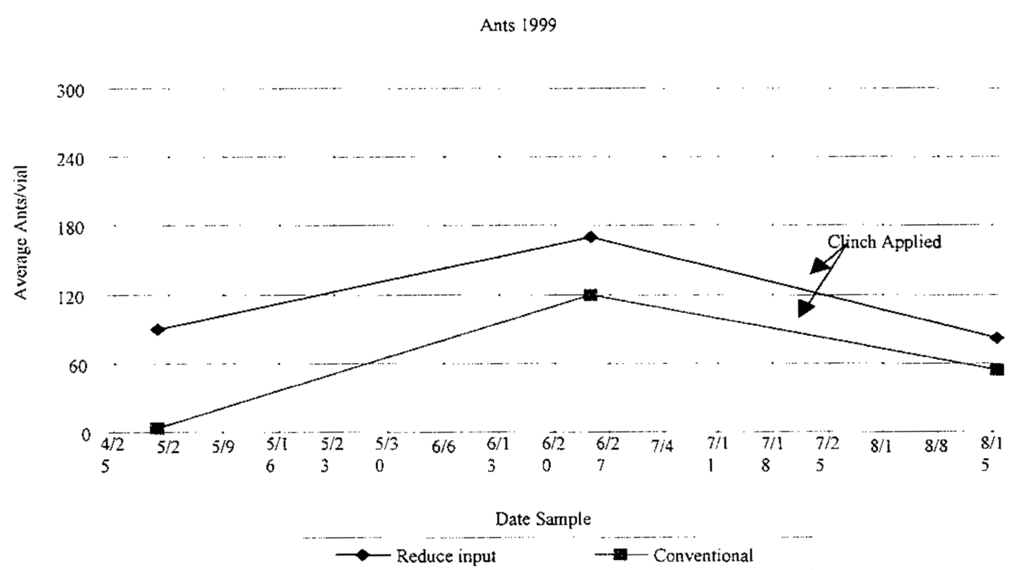
The adult population of PTB was lower in 2000 than in 1999. Please look at Graph 5 and Graph 7. There were distinctive peaks in early April, late May and mid-October, and generally speaking, the conventional had higher counts than the reduced input. Again, looking at Graph 4, one may conclude that the conventional dormant spray program doesn't control PTB.

Graph 7. Kern Co. The average number of PTB adults per trap during the 2000 season in both conventional and reduced input spray programs.

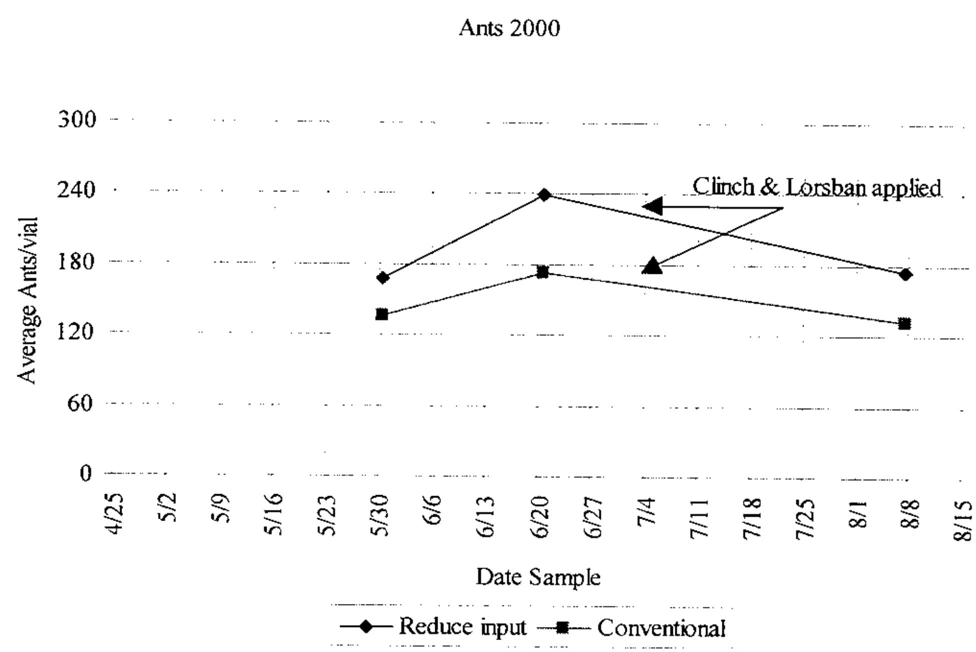


The organophosphate (Diazinon® 1999) and (Lorsban® 2000) reduced the ant population in the 1999 and 2000 season. Graphs 8 and 9 show a reduction in ant population in the conventional spray program in both seasons.

Graph 8. Kern Co. Average number of ants per vial on both reduced input and conventional programs from three different sampling dates.



Graph 9. Kern Co. Average number of ants per vial on three sampling dates on both conventional and reduced input dormant programs.



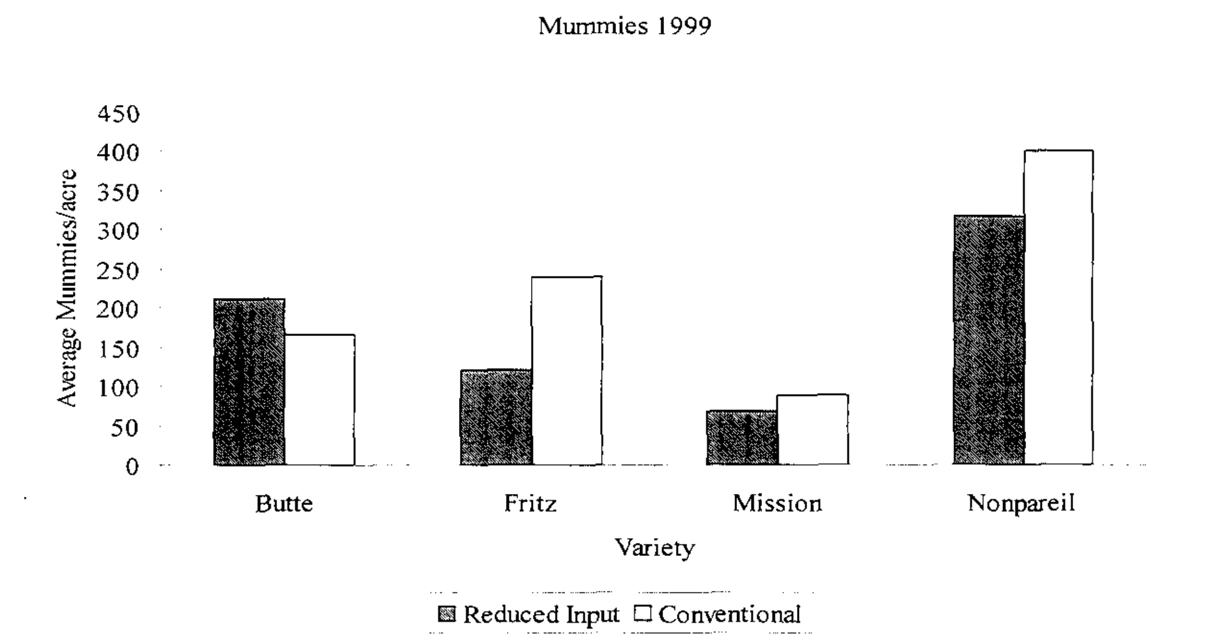
Winter Sanitation

Mummy removal (the elimination of last year's nuts) or sanitation and timely early harvest can reduce navel orangeworm (NOW) between 0 and 4% in the Southern San Joaquin Valley.

In 1999, sanitation was done and evaluated in January. Five percent of the trees per row of Nonpareil, Fritz, Butte, and Mission varieties were surveyed. After walking in one or two trees, every 18^{th} tree was selected for a total of four trees per row; total mummies per tree were counted, including sticktights and mummies that had been cleaned out by birds.

Graph 10 shows the results of this evaluation. There were less mummies per tree in the Butte variety from the conventional than from the reduced input. However, there were more mummies in Fritz, Mission and Nonpareil varieties in the conventional than on the reduced input. Unfortunately, both reduced input and conventional programs had more mummies than is recommended in the IPM manual. The recommendation is two mummies per tree.

Graph 10. Kern Co. Average number of mummies per tree in Butte, Fritz, Mission and Nonpareil varieties from the reduced input and conventional programs.

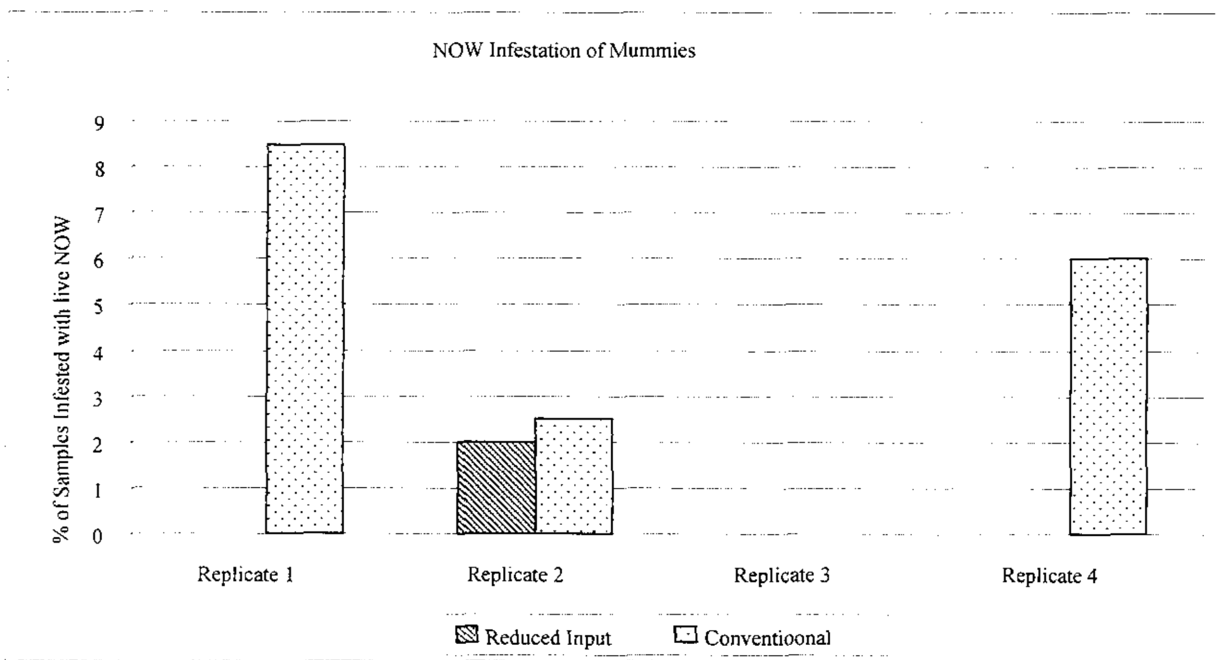


In the 2000 winter season, sanitation was also done and evaluated in January. Approximately 2.5 percent of each variety were checked. In addition to counting the mummies remaining in the trees, samples were brought in and examined for infestation of live navel orangeworm (Graph 11). These samples were not variety specific, but represented the "in orchard" infestation of navel orangeworm. The general trend is for hard shell varieties to have more mummies (Table 2). It was noted that there were very few mummies on the ground. By returning to the orchard after dark, we found a lot of field mice. It is assumed they are feeding on the mummies that fall to the ground.

Table 2. Average number of mummies per tree from different varieties in both the conventional and reduced spray programs.

	Average Number of Mummies per Tree	
Variety	**Conventional**	**Reduced Input**
Fritz	1.035	.100
Nonpareil	0	.035
Sonora	0	.030
Monterey	0	NA
Mission	3.635	.935
Butte	0.735	.535
Padre	6.670	5.730
Thompson	0	.200

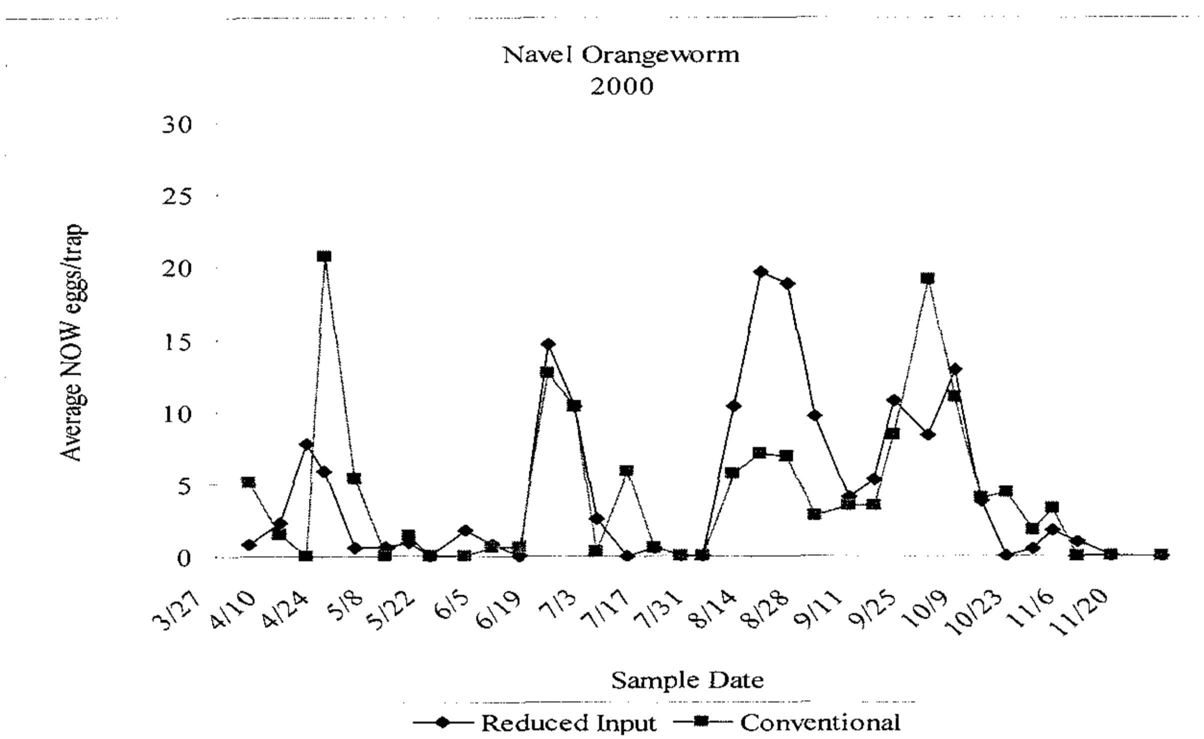
Graph 11. Kern Co. Navel orangeworm infestation of mummies from the four replications and from both conventional and reduced input program.



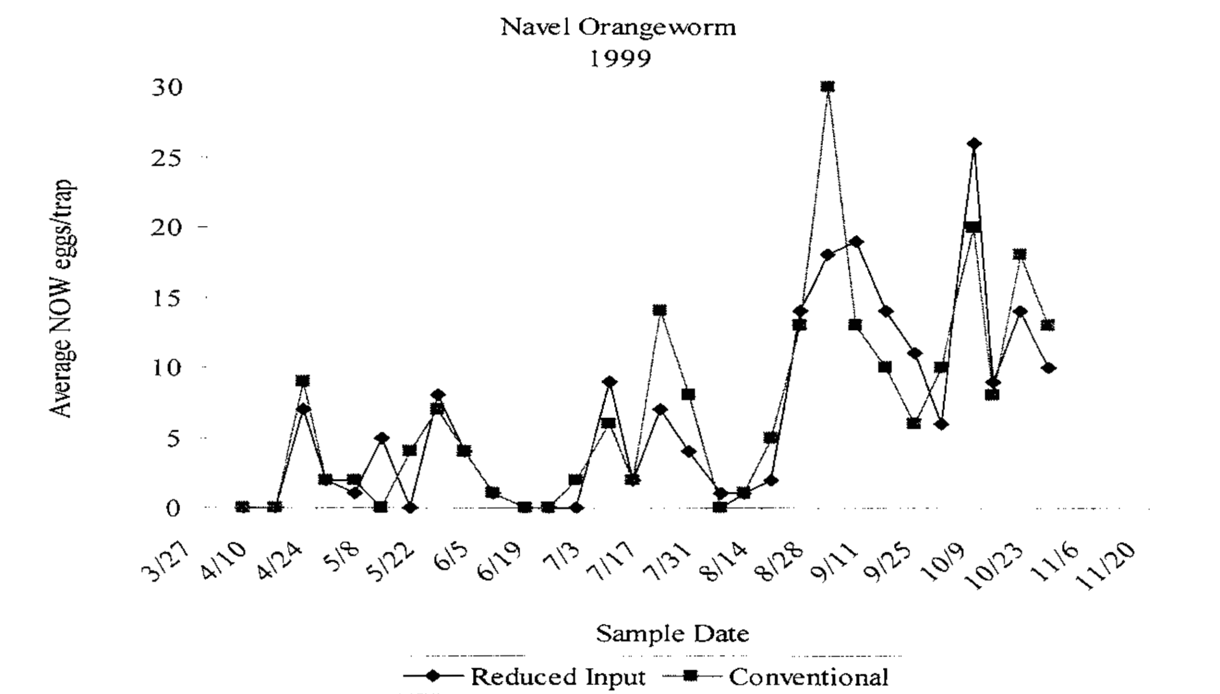
The percent of NOW infestation was acceptable. However, the percent of infestation in the conventional was higher than in the reduced input programs.

The average number of eggs of NOW for the 1999 and 2000 growing season are found in Graph 12 and Graph 13 respectively. In the 1999 season, the number of eggs per trap from the first generation is slightly higher in the reduced input than in the conventional program. However, this situation drastically changes in the second and third generation, where the number of eggs per trap is significantly higher in the conventional than in the reduced input. It appears that Success® at 6 oz. per acre or Imidan® at 5 1/3 lbs. per acre (applied at hull split) had no effect in reducing NOW eggs. It is possible, however, that organophosphate (dormant spray) and Imidan® (hull split) may have affected NOW predators in the conventional blocks. In the 2000 growing season, during the first generation, the number of NOW eggs per trap were higher in the conventional program than in the reduced input program. There were no differences between these two programs during the second generation, but on the third generation, the number of NOW eggs were higher in the reduced input than in the conventional program. During the fourth generation, however, the number of eggs reversed from the reduced input to the conventional. The Imidan® spray at 5 1/3 lbs per acre may have reduced the number of eggs per trap during the second generation in the conventional program.

Graph 12. Kern Co. Average number of NOW eggs per trap from April to October in the conventional and reduced program.



Graph 13. Kern Co. Average number of NOW eggs per trap from April to October in the conventional and reduced input program.



San Jose Scale

San Jose Scale (SJS), *Quadraspidiotus perniciosus*, was monitored in the Kern County Pest Management Alliance Orchard using three methods. On February 25, SJS sticky traps were baited with SJS pheromone loaded rubber septa (Tre' ce') to monitor male scale flight in each of the eight almond plots. Two such traps were placed approximately 1/3 the way in from each of the north and south ends of the plots. Male scale, and the two key parasitoids, *Encarsia perniciosi* and *Aphytis spp.*, were counted weekly. In late March, a single limb from each of the trees at the four compass points around the tree holding the pheromone trap were wrapped with double sided sticky tape to monitor SJS crawlers. Finally, in December, 100 spurs were collected from each plot to determine infestation, scale growth stage, parasitism, and wood mortality.

Monitoring was done to detect short-term differences in scale abundance, and long-term establishment of SJS and associated parasitoids and the impact these arthropods have on wood mortality.

Graph 14 presents the dynamics of SJS male flight in both the reduced input and the conventional program. No differences in flight trends could be detected. A total of 929 dd (51°F lower and 90°F upper threshold) were accumulated from the beginning of overwintering scale flight on March 17 to the beginning of the next flight on May 22. The second flight started on May 22nd. From May 22 to July 12 (beginning of third flight) required 1188 dd. Estimated average development time is 1050 dd. Remaining flights were not clearly discernable, but continued in early November. Although more males were trapped under the conventional program of dormant oil and organophosphate dormant spray (3720 SJS) compared to the reduced input of oil spray only (2861 SJS), these numbers were not statistically different.

Encarsia perniciosi abundance found on SJS pheromone traps was virtually identical between the two treatments. The reduced input treatment averaged 920 *Encarsia* per season and the conventional treatment averaged 819 *Encarsia* per season.

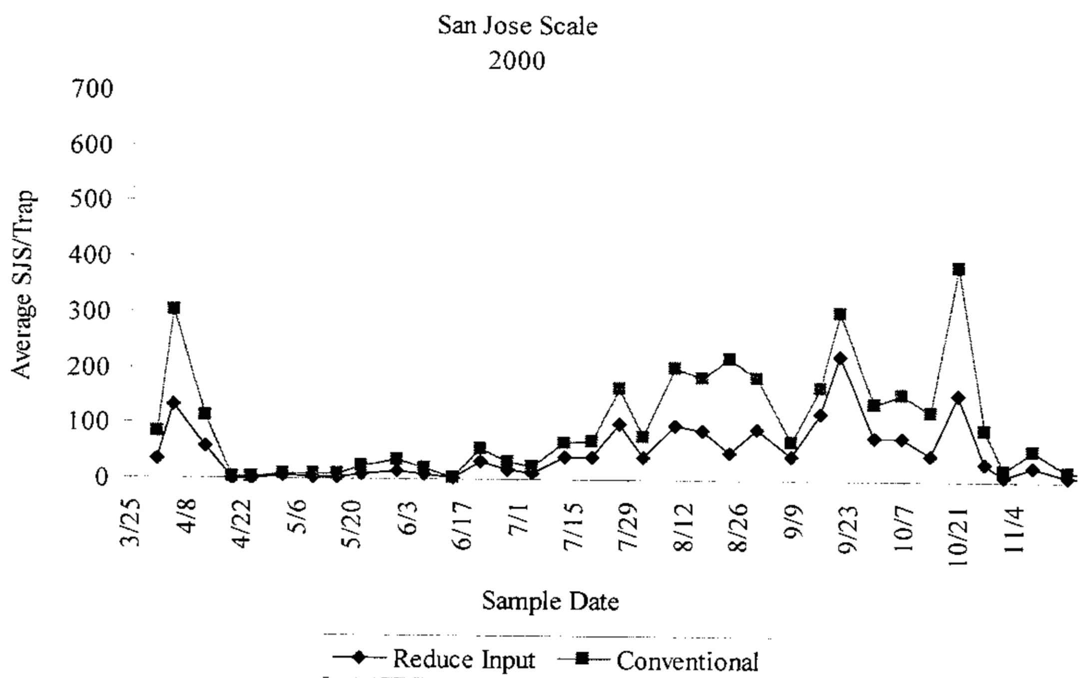
Crawler abundance for the year 2000 has not been tabulated to date. Although there does appear to be significantly more crawlers in the reduced input block, the higher numbers were found in only one replicate. In 1999, an average of 4.71 crawlers per inch of tape were found in the reduced input and 1.26 crawlers per inch of tape in the conventional.

The 1999 trends in crawler abundance will be compared to the 2000 trends. From the 1999 work, a more thorough job of dormant oil spray may be necessary to keep the apparent trend in Graph 15 from continuing.

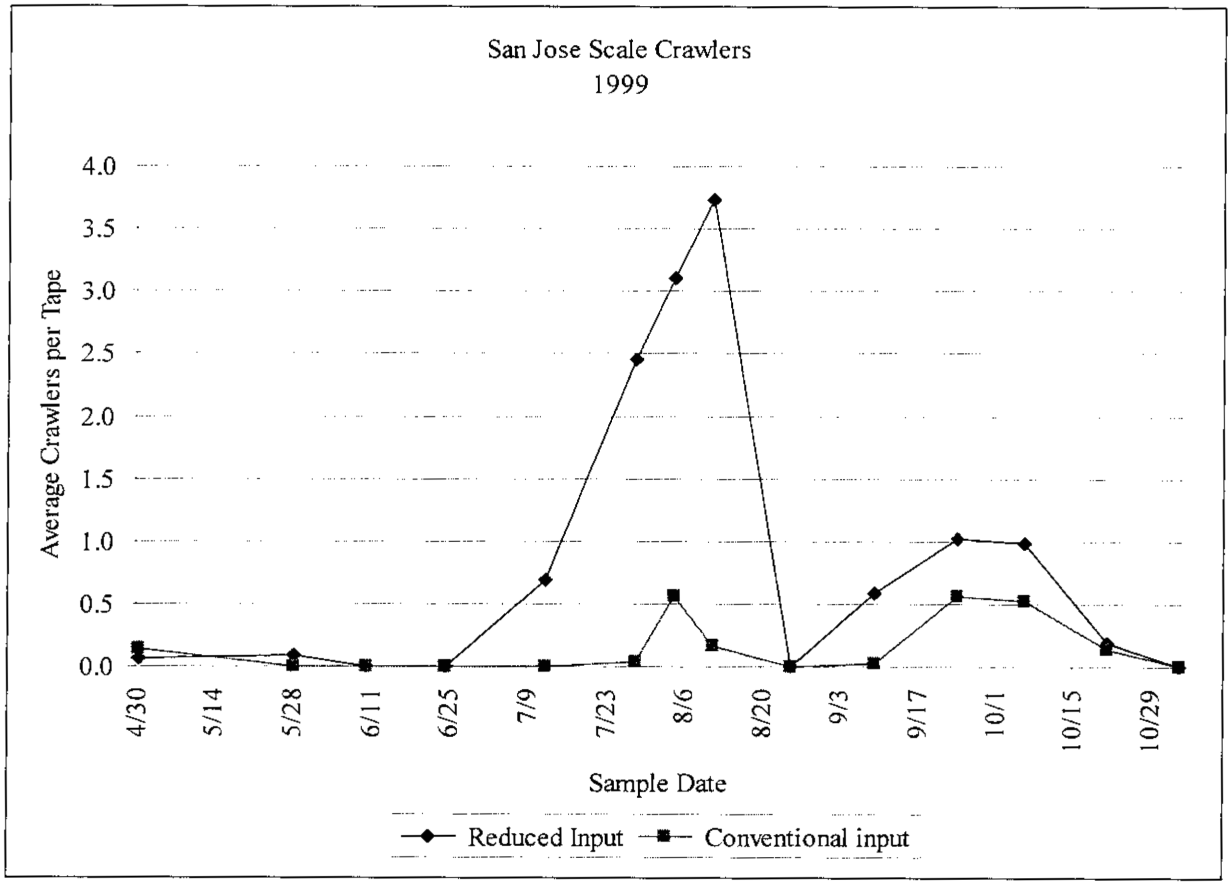
Sampling for wood damage during December 1999 resulted in no scale damaged wood. The reduced input sampling of 240 spurs averaging three inches in length resulted in three spurs with a single black cap scale. Only one spur was infested in the conventional treatment (four scale on the one spur).

As the double sided sticky tapes and spur samples are counted, these figures may change. However, the use of a dormant oil alone in 1998 has not resulted in damaging populations of SJS in the orchard studied. We will also be evaluating parasitism in the dormant spur sampled wood to detect differences in parasitism between the two treatments.

Graph 14.Kern Co.



Graph 15. Kern Co.

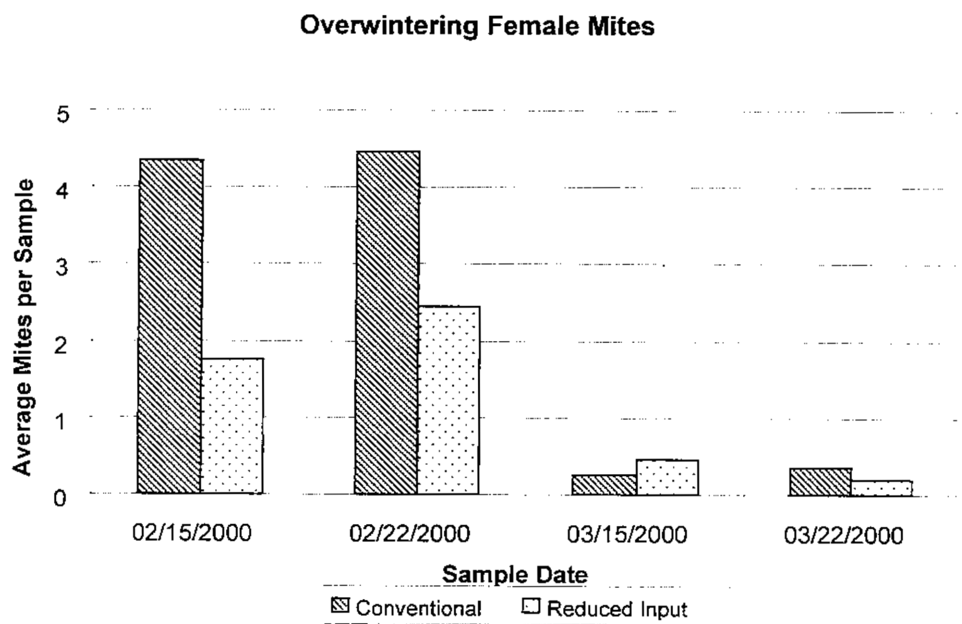


Mite Management

Mites are the most difficult and most expensive pests in almonds in the Southern San Joaquin Valley. It is a pest that is predisposed by high temperatures and water stress. High temperatures of 100°F or more plus water stress in the trees can lead to an explosion of mites in the orchard. In some years, three or more miticide sprays are required to bring mites under control. If mites are not controlled, yields can decrease up to 20% the following year.

Soil monitoring was started in the 2000 season. The objective was to determine overwintering mites in the soil in both conventional and reduced input programs. There were four soil sampling dates: February 15, February 22, March 15, and March 22nd. The soil samples were taken from the base of the trees and placed in eight ounce Styrofoam cups which were filled to the rim. Then, they were placed on a sticky card and left at room temperature for two weeks. After two weeks, the overwintering female mites emerged from the soil and got stuck on the cards. The sticky cards were then read and the overwintering female mites were recorded. Graph 16 shows the results of soil monitoring. There was a significant difference between the conventional and reduced input program at the February 15 soil sample. There were more overwintering female mites coming from the conventional than from the reduced input. There were differences in the number of overwintering female mites in the February 22 soil sample, but the differences were not significant. The soil samples for March 15 and 22 did not show any significant differences in overwintering female mites.

Graph 16. Kern Co. Average number of overwintering female mites in soil samples taken on February 15, February 22, March 15, and March 22.



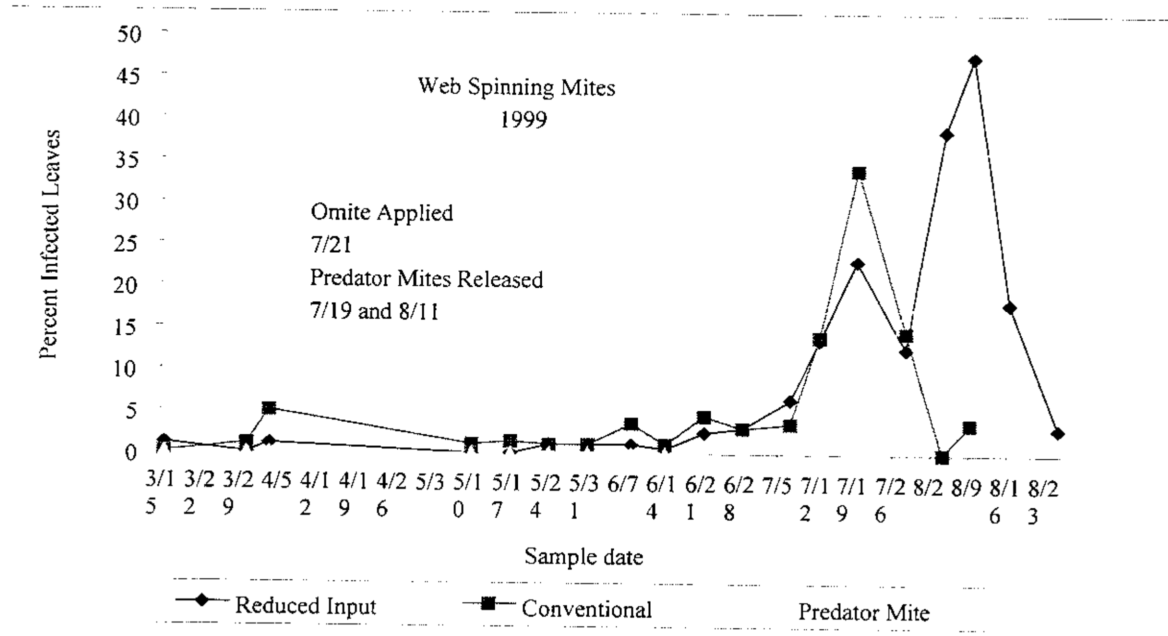
In the 1999 growing season, mites were monitored in Nonpareil and Butte varieties in the PMA orchard every other week from mid-April to mid-May, then weekly until the end of August. Both conventional and reduced input blocks were checked until mid-August, when only the reduced input blocks were monitored. Five trees per block were selected at random from the south and north ends of the plot one week, then along the center road the next week. Five leaves per tree, mostly from the lower interior portion of the tree, were examined initially; when weekly monitoring began in mid-May, ten leaves per tree were checked, half from the interior and half from the exterior of the tree. Leaves were pulled at approximately head height from all around the tree and both upper and lower leaf surfaces were examined with a hand lens for web spinning spider mites (adults, immatures, and eggs); predatory mites (adults and eggs); and sixspotted thrips. The presence/absence method of counting was used, indicating the number of leaves out of five or ten leaves where mites were seen, not the actual number of mites. Also noted were presence of European red mite, lacewing eggs and larvae, substantial webbing or multiple mites on leaves, and any other information of interest.

For the 2000 growing season, leaf monitoring for mites on Nonpareil and Butte varieties began in mid-April. Five trees were selected at random from the south and north ends of the plot one week, then along the middle avenue the next week. Ten leaves were selected from each tree. Initially, only interior leaves were selected, however, by mid-May, half of the leaves were selected from the interior and half from the exterior of the tree. Until mid-May, leaves were examined in the field with the use of a hand lens. From mid-May through the first of August, leaves were brought back to the lab, in an ice chest, and examined under a microscope. The presence/absence method of counting was used, indicating the number of leaves out of ten where web-spinning mites were seen, not the actual number of mites. Also noted were presence of European red mite, predatory mite and sixspotted thrips.

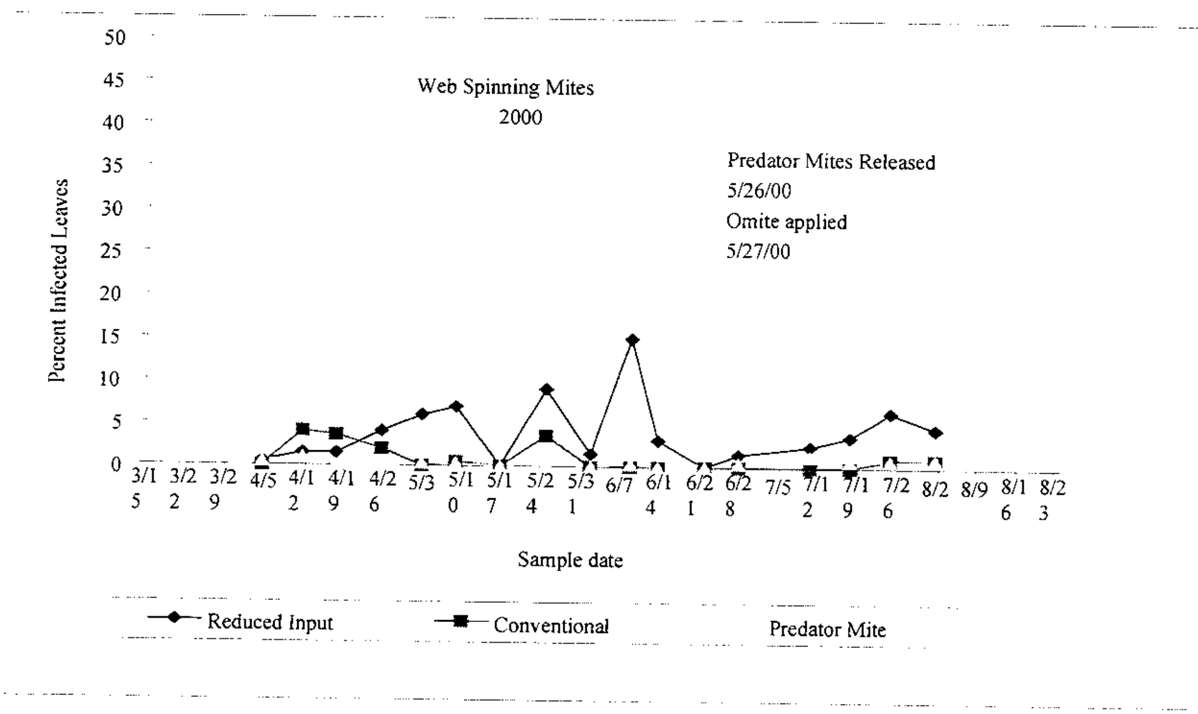
The mite data has been plotted on Graph 17 for 1999 and Graph 18 for 2000. These two graphs show two different mite situations. This really demonstrates that mite control cannot be done by calendar sprays. It has to be done based on monitoring. In 1999, mites did not appear until July 7 and increased to a treatable level on July 19. At this time, the conventional program was treated with Omite® (every other middle) at four pints per acre. This spray was very effective and by August 4, the mites were under control. The predator mites were not released in the reduced input program until the web spinning mite population increased to a food supply level which was reached on July 19th. At this time, 2,500 predatory mites per acre were released. At the beginning, this release did not appear to control the web spinning mite infestation. Therefore, another 2,500 release was made August 11th. After this second release, web-spinning mites did become under control.

In the 2000 season, the web spinning mites appeared very early in the season (Graph 18) and decreased at the end of the season. The mite population never reached a treatable level. Nevertheless, the conventional program was treated every other middle with Omite® at four pints per acre. This spray crashed the mite population through the end of the season. Predatory mites were released in the reduced input program at a rate of 2500 mites per acre. There was only one predatory mite release and it was done at the same time as the Omite® spray. The 2000 growing season was a cool one and a miticide spray was not needed for mite control.

Graph 17. Kern Co. Percent of leaves infested with web spinning mites during the season in both conventional and reduced input programs.



Graph 18. Kern Co. Percent of leaves infested with web spinning mites during the season in both conventional and reduced input programs.



Peach Twig Borer Emergence

PTB is a key pest in almonds. In some years, it can be more damaging than NOW. In the future, growers may not be able to use organophosphate (OP) sprays for its control. At the present time, however, there is an alternative for OP. The alternative is *Bacillus* *thuringiensis* or Bt. For Bt sprays to be effective, one needs to determine PTB emergence, or when the PTB larva leaves the hibernacula.

The PTB emergence curve was determined for the PMA orchard for 1999. The procedure was based on collecting rust-colored hibernacula (minute chimney-like piles of frass and sawdust) from crotches (branch angles) of trees. With a grafting knife, a pie-shaped wedge containing the hibernacula was cut from the crotches and placed into a vial. Ten hibernacula were collected per block. Under the microscope, the hibernacula was opened with a probe and the presence or absence of the larvae was noted. Absent larvae meant it had emerged. Therefore, emergence was determined by the number of absent larvae. The weekly samples were taken from early February to mid-March. Table 3 shows the percent emergence of PTB and bloom development for 1999. Unfortunately, we were unable to replicate this data for 2000 because we were unable to find hibernacula.

Table 3. Kern Co. Percent of PTB emergence and percent of bloom on Nonpareil at different dates from both conventional and reduced input spray programs.

Date	Reduced Input	Conventional	Bloom
02-15-99	15%	9%	0%
02-19-99	18%	27%	5%
02-26-99	25%	24%	30%
03-05-99	50%	55%	100%
03-12-99	77%	75%	-0-
03-19-99	85%	88%	-0-

The data on Table 3 tells us that PTB emergence does not develop at the same rate and time as the bloom. Therefore, the proper timing of Bt spray (at 50, 80, and 100%) must be based on PTB emergence.

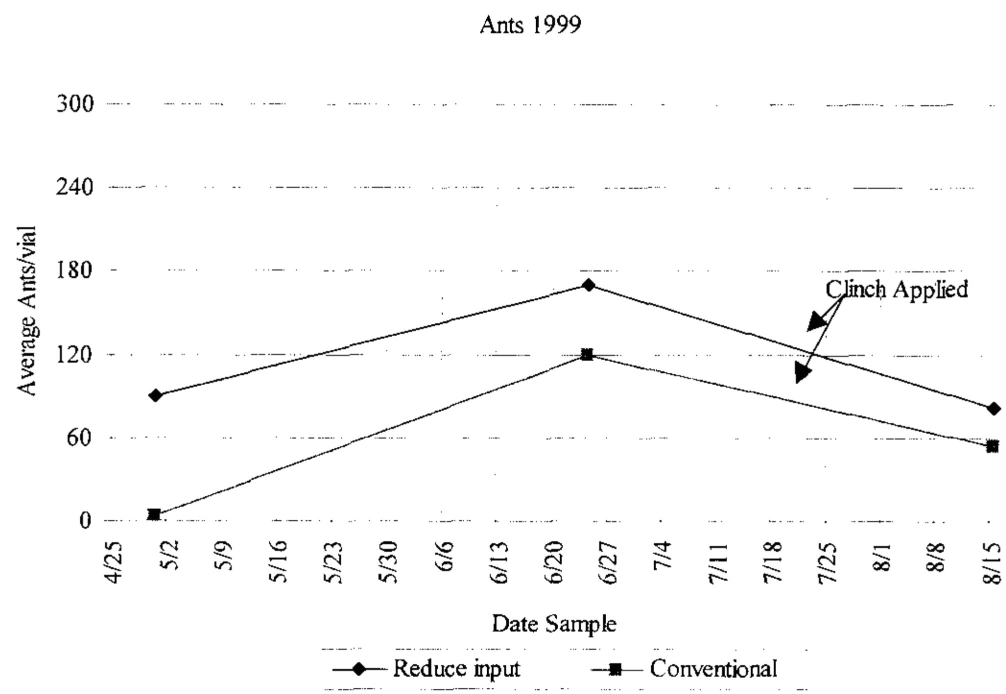
Ant Management

Ants can cause more damage to almond meats than NOW and PTB. Orchards that are harvested early and/or with a good cover crop in the middles are most susceptible to ant damage.

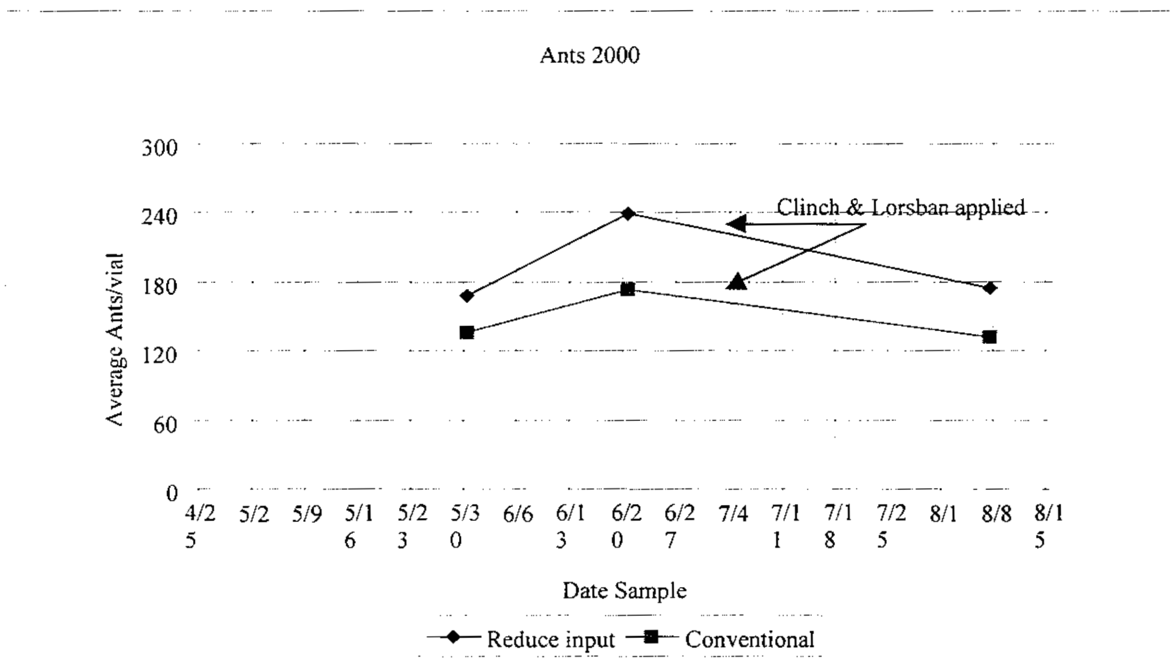
The hot dogging method was used to determine the level of ant activity within each block. A half-inch hot dog slice (Bar-S brand containing beef, pork, and chicken) was placed in a snap-cap vial; 15 vials were placed in each of three rows per block, with five vials in the center of the middle and five vials along each berm. After walking in 15 trees, vials were dropped every 11 trees. Vials were distributed in the orchard during early morning ant activity for a duration of two hours, then picked up and stored in the freezer until counting. Sample processing involved removing ants from the hot dog and vial by washing them into a large petri dish for counting. All ants per vial were individually separated and counted.

Graph 19 and Graph 20 show the ant population at three sampling dates during the growing season. In both years, 1999 and 2000, the ant population was higher in the reduced input than in the conventional program. The reason may be due to the fact that the conventional programs received organophosphate sprays during the dormant and hull split period. The preharvest sprays of Clinch® and Lorsban® did not appear to have a dramatic effect in the control of ants.

Graph 19. Kern Co. Average number of ants per vial on both conventional and reduced input programs in 1999.



Graph 20. Kern Co. Average number of ants per vial on both conventional and reduced programs in 2000.



Bloom

Bloom is a very susceptible disease period in almonds. During bloom, almonds are susceptible to blossom rot, brown rot, green fruit rot and shothole disease. All these diseases require moisture to become a problem. Therefore, if one can predict rain or fog, we will be able to predict diseases. It is a common practice to apply two fungicide sprays: one at the onset of bloom and another at full bloom. These two sprays provide adequate protection to almond orchards in most years.

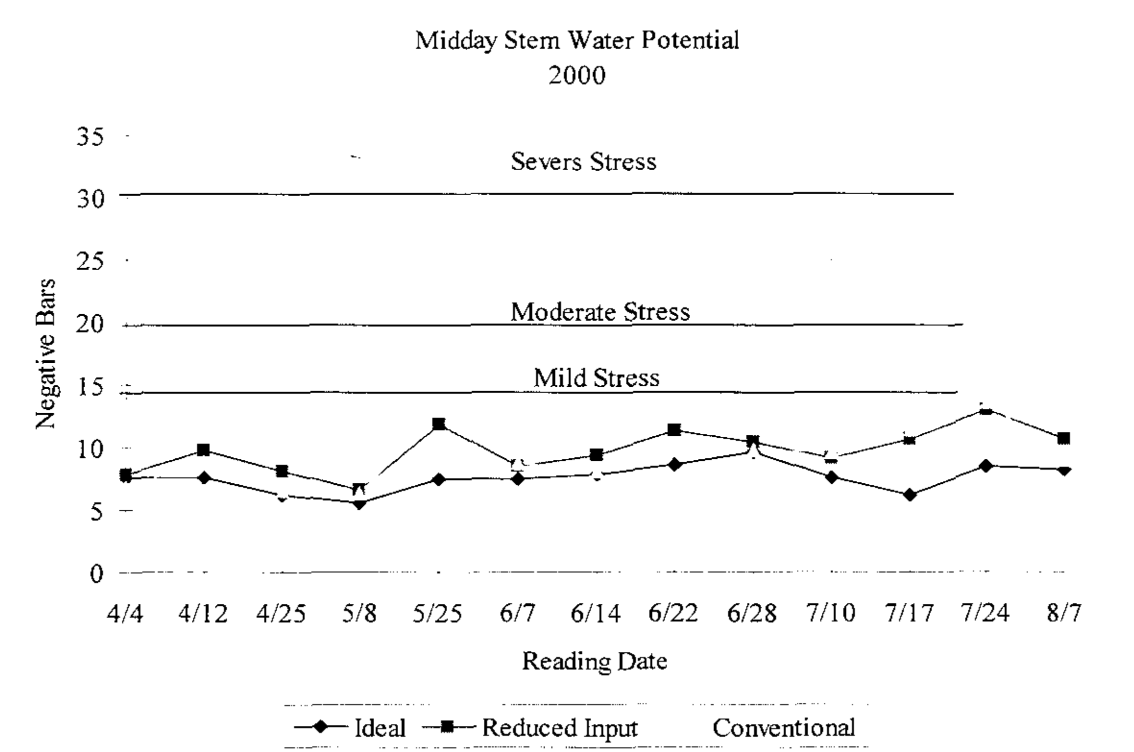
In 1999, Sonora was the only variety that received a fungicide spray at full bloom. The fungicide was Rovral® at one pound per acre in 200 gallons of water. The spray was applied to every other middle. This spray was enough to provide protection for bloom diseases. In 2000, the whole PMA orchard was sprayed with tank mixture of Captan® (5 pounds) and 1.25 pounds of TopSinM® in 200 gallons of water. The spray was applied to every other middle. This spray was effective in controlling bloom diseases in the orchard.

Irrigation Monitoring

Mite problems in an almond orchard can be predisposed by poor irrigation practices that create tree water stress. Irrigation practices in the orchard were monitored with weekly pressure bomb readings. Readings were taken on two trees in each 20-acre block. One tree was located on the north side of the block, the other on the south. In both cases, this was the third tree in from the road. In the morning, a small plastic-lined foil bag was used to cover a lower canopy leaf that was close to the trunk or main scaffold. Measuring took place at midday, usually about 1:00 p.m., when evaporative demand was at its peak. The leaf was removed from the tree and the end of the petiole cut with a razor so it had a uniform flat surface to view with a hand lens. The leaf was placed in the chamber with a small amount of petiole exposed. Measurements are made by raising the pressure in the chamber until water begins to come out of the xylem.

The pressure bomb measures the water tension in the xylem. Then, by knowing the temperature and relative humidity when the readings were taken, one can determine what values to expect for a fully irrigated almond orchard. Graph 17 shows that the orchard (conventional and reduced input programs) has been irrigated well. In 1999, the orchard was maintained around the mild stress level. However, in the 2000 season, the orchard was maintained below the mild stress level.

Graph 21. Kern Co. Mid-day stem water potential of trees in conventional and reduced input program for the 2000 and 1999 growing season.



The Leaffooted Bug (*Leptoglossus clypealis*)

Some years, the leaffooted bug has been reported to be an insect problem in Fresno County. In Kern County, it has never been a serious problem in almond orchards. This year, however, it became a serious pest in many Kern County orchards, including the PMA orchard.

In the spring we decided to evaluate the damage of the leaffooted bug in three main varieties in the PMA orchard. Ten, 30 nut samples were gathered at random from two blocks of conventional and reduced input programs for three varieties; Sonora, Fritz and Nonpareil. The samples were evaluated for stings on the hulls (outside), inside gumming and stings on the kernel. The results can be found on Table 4.

The Sonora variety appears to be the most attractive to the leaffooted bug. It had a greater percentage of outside stings, inside gumming and kernel stings than any other variety in both conventional and reduced input programs. However, the percent of damaged nuts was higher in the reduced input than on the conventional. The Fritz variety was second to Sonora and the least affected by the leaffooted bug was the Nonpareil.

Table 4. Kern Co. Percent of nuts showing outside stings (hull), inside gumming, and kernel stings in Sonora, Nonpareil and Fritz.

Program	Variety	Outside Stings (Hulls) %	Inside Gumming %	Kernel Stings %
Conventional	Sonora	20.5	12.5	6.5
	Fritz	9.5	6.0	5.0
	Nonpareil	1.5	0.0	0.0
	Total	31.5	18.5	11.5
Reduced Input	Sonora	24.5	27.5	20.0
	Fritz	6.5	22.0	0.0
	Nonpareil	3.0	0.0	0.0
	Total	34.0	49.50	20.0

Orchard Nutrition

The nutritional levels of both conventional and reduced input programs have been monitored by leaf samples taken in June-July every year. Three sets of 100 leaves samples are taken from both the conventional and reduced input programs. The samples are washed in distilled water, air dried, ground through a Wiley mill and sent to the ANR Laboratory at UC Davis. Table 5 shows the nutrient levels for the past two years.

There are no nutritional differences between conventional and reduced input program. This was expected since the fertilization program has been the same for both conventional and reduced input. However, there are two nutrients of concern, nitrogen and boron. The nitrogen in 1999 was very high; however, it did decrease in 2000. The high nitrogen is due to the age of the orchard, which is young and has not come into full production. The boron levels are marginal. They need to be around 40 to 50 PPM. The grower applied four pounds of Solubor® per acre after 2000 harvest.

Table 5. Kern Co. Tree nutrient levels for 1999 and 2000 in the conventional and reduced input programs.

	Reduced Input		Conventional	
	1999	2000	1999	2000
N-Total (%)	3.25	2.81	3.26	2.82
P-Total (%)	0.18	.15	0.18	.16
K-Total (%)	1.95	1.87	1.88	1.81
Na (ppm)	109	239	110	203
Cl (%)	0.07	.109	0.08	.030
B (ppm)	34	36	34	36
Adequate Levels				
N-Total (%)	2.3-2.6			
P-Total (%)	0.1-0.3			
K-Total (5%	1.2-1.8			
Na (ppm)	Excess over 2500			
Cl (%)	Excess over 0.3			
B (ppm)	30-65			

Yields of Nonpareil and Butte from both conventional and reduced input programs have been taken to measure the influence of insect damage, cover crop and oil sprays on tree productivity. Six rows of each variety (Nonpareil and Butte) were selected from both conventional and reduced programs. The rows were selected at random and represent 21% of the Nonpareil and 26% of the Buttes in the PMA orchard. Commercial harvesting equipment was used. The nuts from each row were weighed on a 40,000-pound capacity platform scale. Two four-pound samples were taken from each load at the elevator.

Table 6. Kern Co. Kernel weight and yields (lbs./ac) from the conventional and reduced input programs.

		Kernel Weight (g)		Yield (lbs./Ac)	
Program	Variety	1999	2000	1999	2000
Conventional	Nonpareil	1.04	1.31	794	787
	Butte	0.90	1.03	760	896
Reduced Input	Nonpareil	1.06	1.32	701	716
	Butte	0.90	1.09	804	823

Note: None of these figures are significantly different.

Reject Levels

Reject levels were determined from 16 different nut samples. Each block was sampled in four quadrants making our sample representative of the block. The kernels, once cracked, were examined for navel orangeworm, peach twig borer and ant damage.

Table 7 shows the percent of reject levels in the Nonpareil and Butte varieties due to ants, NOW and PTB for the conventional and reduced input programs. The total reject level doubles from 1999 to 2000 in the Nonpareil variety. Also, there were no differences between the conventional and reduced input programs. Both showed a high reject level. Let's examine each pest. In 1999, Clinch® was applied to both conventional and reduced input programs. In 2000, the conventional program was treated with Lorsban® and the reduced input program was treated with Clinch®. Ant damage levels in the conventional program decrease in the Nonpareil from 1.86% in 1999 to 0.13% in 2000. This means that Lorsban® works better than Clinch®. NOW reject levels between conventional and reduced input was not substantially different. PTB reject levels for the 2000 season was very high. Nonpareils in the conventional program went from 0.26% in 1999 to 4.40% in 2000. The increase in reject levels is hard to explain. There were low shoot strike counts in the spring and low moth catches during the season but a high reject level. The Butte variety was really infested with NOW and PTB in both the conventional and reduced input program.

A reasonable explanation may be due to poor shell seal. We found that 70% of Butte nuts had an open suture.

Table 7. Kern Co. Percent of reject levels in Nonpareil and Butte due to ants, NOW and PTB from the conventional and reduced input programs.

		Ants (%)		NOW (%)		PTB(%)		Total (%)	
Program	**Variety**	**1999**	**2000**	**1999**	**2000**	**1999**	**2000**	**1999**	**2000**
Conventional	**Nonpareil**	1.86	0.13	0.19	2.81	0.26	4.40	2.31	7.34
	Butte	----	0.51	----	9.32	----	9.11	----	18.94
Reduced Input	**Nonpareil**	3.46	0.14	0.12	2.09	0.06	5.88	3.58	8.11
	Butte	-----	0.92	----	7.99	-----	8.49	----	17.40

Summary of Conclusions

Monitoring. This practice is essential to gain knowledge of the pest and diseases in an orchard. The knowledge acquired will allow a grower to reduce pesticide usage and therefore production cost.

Cover Crops. The greatest benefit of a cover crop such as barley is an increase in water penetration. This finding has solid support in literature.

Dormant Sprays. Controls San Jose Scale and ants but it does not control peach twig borer. It was a general belief that organophosphate in the dormant spray controlled PTB. This study doesn't support this belief. However, for two years, the organophosphate decreases ant populations.

Winter Sanitation. Winter sanitation plus an early harvest reduces NOW damage. There were very low reject levels in 1999 and 2000 due to excellent sanitation.

In Season Sprays. Hull split spray has no value in controlling PTB and/or NOW in a clean orchard. In fact, one can create mite problems with in season organophosphate spray.

Mite Control. It is important to keep an orchard well irrigated. This will decrease the predisposition of trees to mite build up. Monitoring is a must for mites. It can save unnecessary spray.

Shell Seal. Poor shell seal can lead to high NOW and PTB reject levels. Poor shell seal may be a function of high nitrogen level, excessive irrigation and low temperatures during spring and summer.

Appendix A

Vetsch Reduced Input Trial Systems comparison 1999-2000

	Conventional				Reduced Input			
Chemical Applications	Date	Treatment	Rate	Cost/Acre	Date	Treatment	Rate	Cost/Acre
Dormant Dormant	1/4/99 1/17/00	Diazinon® Oil Lorsban 4E® Oil Leaf Life®	5 pints/A 6 gal/A, 200 GPA 3 pints/A 4 gal/A 239 GPA 7 oz/A	 $15.75 $9.80 $0.90	None 1/17/00	 Oil	 6 gal/A, 230 GPA	 $14.70
Bloom Bloom	2/22/99 3/1/00	Rovral® (Sonoras only) Captan® TopSinM® Calcium Zinc® Leaf Life®	1 lb/A 5 lb/A 1.25 lb/A 1 pint/A 1 pint/A	 $15.00 $18.31 $1.13 $2.06	None 3/1/00	 Captan® TopSinM® Calcium Zinc® Leaf Life®	 5 lb/A 1.25 lb/A 1 pint/A 1 pint/A	 $15.00 $18.31 $1.13 $2.06
May May	None None				None None			
Hullsplit Hullsplit	7/10/99 7/7/00	Imidan 70W® Imidan®	5 1/3 lb/A 200 GPA 5 1/3 lb/A 200 GPA	 $33.00	7/10/99 7/7/00	Success® Imidan®	6 oz/A, 200n GPA 5 1/3 lb/A 200 GPA	 $33.00
Mites	7/22/99	Omite® (EOM)	4 pints/A		7/19/99	Predatory Mite	2500/A	

Mites	5/27/00	Omite 6E ®(EOM)	4 pints/A	$45.50	8/11/99 5/26/00	Predatory Mite Predatory Mite	2500/A 2500/A	$30.00
Ants Ants	7/28/99 7/3/00	Clinch® Lorsban 4E® Soft shells only	1 lb/A 4 pints/A 100 gal water	$21.00	7/2//99 7/3/00	Clinch® Clinch®	1 lb/A 1 lb/A	$12.00
Weeds Weeds		Roundup®, Gramoxone® Roundup®	1 pint/A 1 pint/A	$4.62 $4.00		Roundup®, Gramoxone® Roundup®	1 pint/A 1 pint/A	$4.62 $4.00
Cover crops	12/21/99	Barley	40 lb/A	$4.00	12/21/00	Trifoil Insectary Mix	10 lb/A	$38.00

175^{07} 172^{82}

Appendix B

1999 "BIOS Insectary Mix

Common Name	%By Weight in Mixture
White Sweetclover	10
'Common Vetch	17
Subterranean Clovers (3-4 Varieties)	20
Crimson Clover	8.3
'Nitro' Persian Clover	5
Cereal Rye	8.3
Triticale	8.3
Barley	8.3
Sweet Alyssum	0.83
Tidy Tips	0.83
Coriander	1.7
Celery	0.83
Bishop's Weed	0.83
Toothpick Weed	0.83
Bee Phacelia	8.3
Yarrow	0.83

2000 Trefoil Insectary Cover Crop Mixture

Common Name	% By Weight in Measure
Birdsfoot Trefoil, Broadleaf	48
Birdsfoot Trefoil, Narrowleaf	6.5
Crimson Clover	4.0
Sub Clover	2.0
Hard Fescue	2.0
Red Clover	1.3
Sweet Alyssum	
Little Burnet	
California Orange Poppy	
Baby Blue Eyes	
Strawberry Clover	
White Yarrow	

Kern County Pesticide Summary

Kern County is one of the largest almond producing counties in California. Since 1990, approximately 15,000 new acres have been harvested, increasing Kern county to almost 80,000 harvested acres. This information is available through the California Agricultural Statistical Service (CASS) via the World Wide Web. Chart 3.1 depicts the amount of harvested almond acreage in Kern County 1990-1998.

Chart 3.1. Harvested Almond Acreage in Kern County 1990-1998

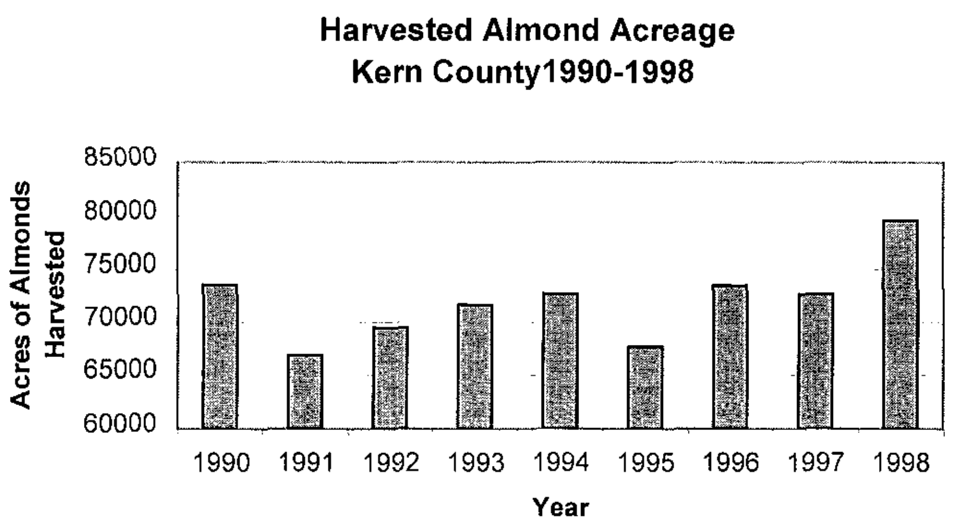
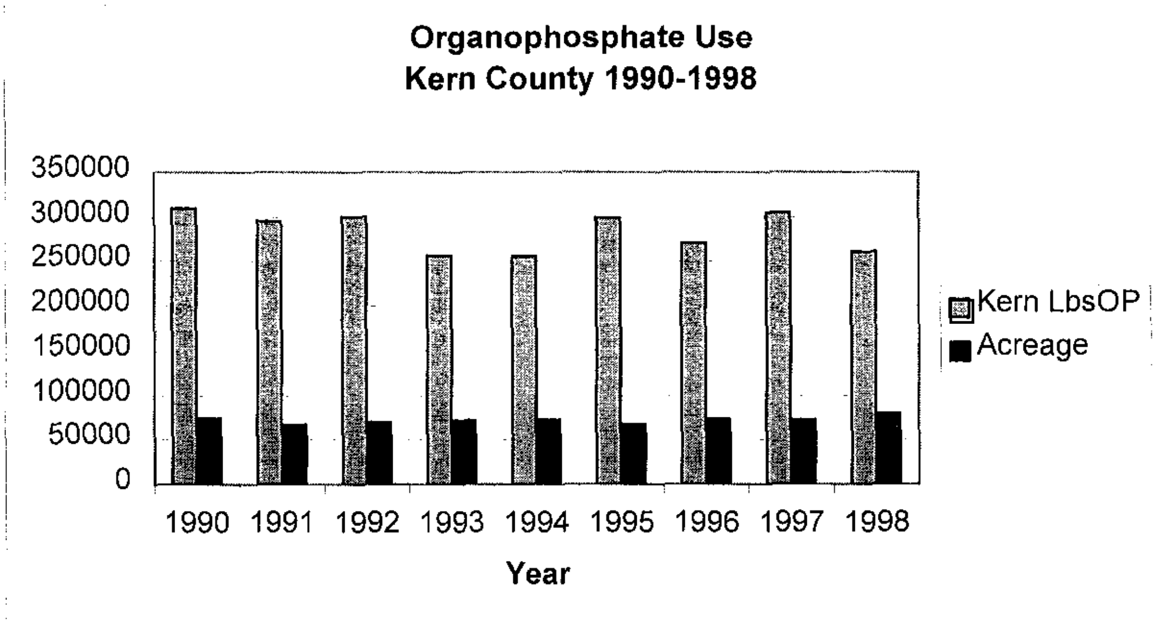


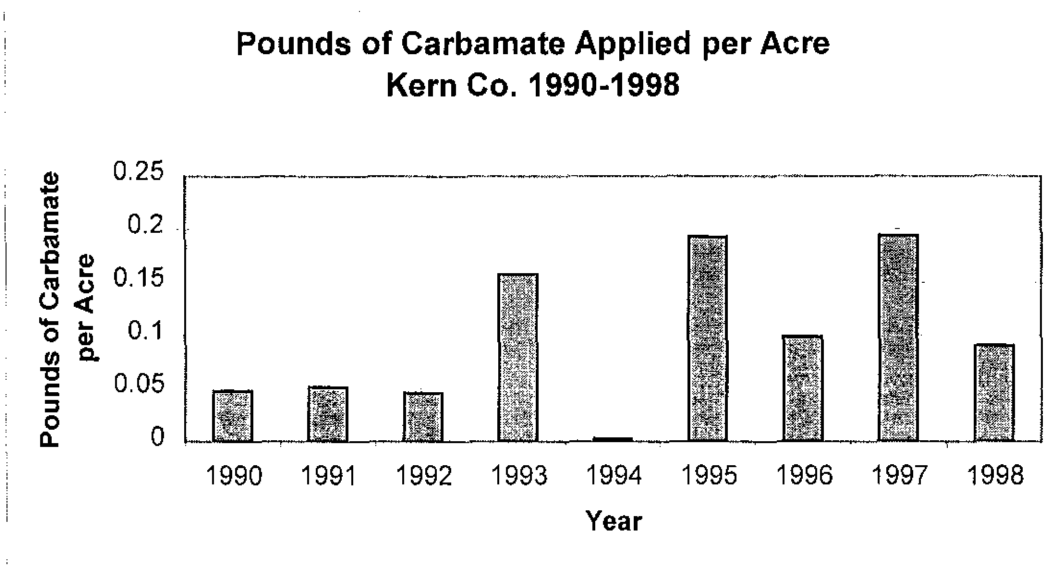
Chart 3.2 depicts the amount of harvested acreage and the pounds of organophosphates applied per acre. Despite the amount of harvested acreage increasing, the amount of organophosphates applied has reduced. This is a positive trend. The organophosphates used in this report are azinphos-methyl, diazinon, chlorpyrifos, methidathion, parathion, naled, phosmidion, and phosmet.

Chart 3.2. Organophosphates applied in Kern County 1990-1998.



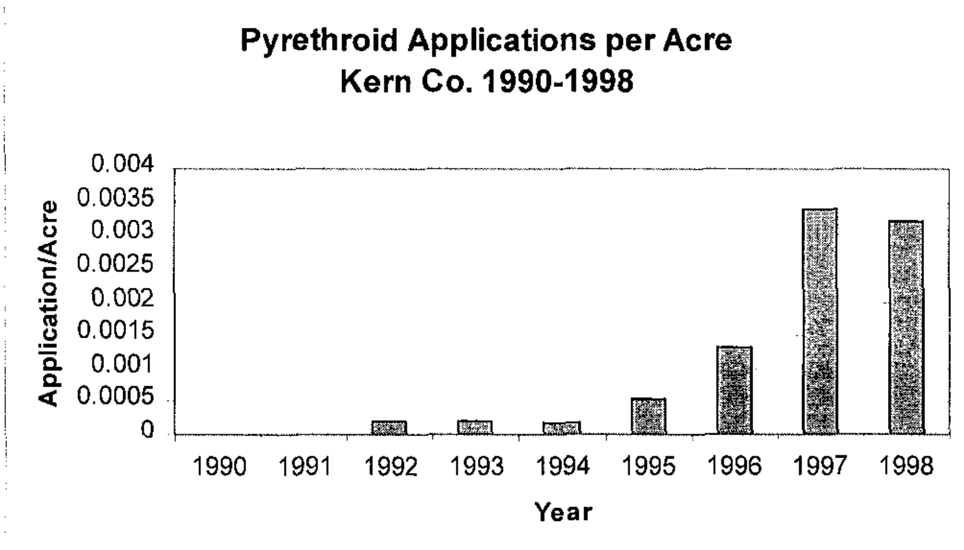
Carbamate use in Kern county has fluctuated over the past nine years. Chart 3.3 depicts the pounds of carbamates applied per acre in Kern County. With the total amount of acres increasing and the amount of carbamate applied dropping in 1998, shows that carbamate use per acre is decreasing in Kern county.

Chart 3.3. Pounds of carbamates applied per acre in Kern County 1990-1998.



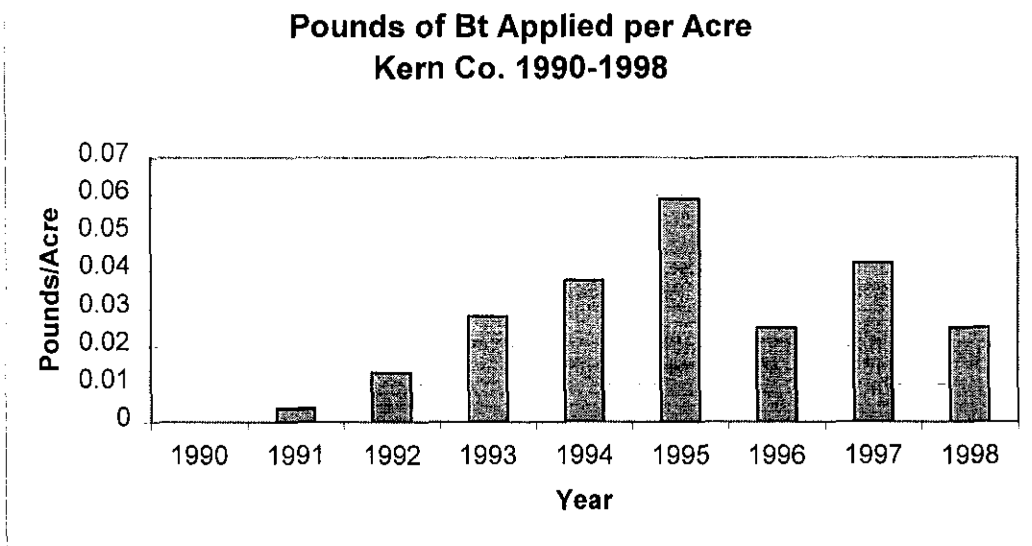
Pyrethroid applications increase from virtually none in 1990 to approximately 260 in 1998. However, the amount of harvest acreage rose by approximately 15,000 acres in this time period. Chart 3.4 shows the number of applications of pyrethroids per acre in Kern County from 1990-1998.

Chart 3.4. Pyrethroid Applications per acre in Kern County 1990-1998.



Pounds of Bt applied in Kern County rose steadily from 1990-1995 but then began to fluctuate. Chart 3.5 shows the pounds of Bt applied in Kern County from 1990 to 1998.

Chart 3.5. Pounds of Bt applied in Kern County 1990-1998.



Despite the fluctuations in the use of organophosphates and carbamates and the steady increase in pyrethroid applications, the amount of acreage has also risen steadily in Kern County. The rise in acres must be addressed in viewing these pesticide use reports. This remains to be the case when viewing the fluctuations of Bt use.

Task 4:

Stanislaus County

Objectives:

1. To scientifically evaluate the success and profitability of managing arthropod pests with less broadly toxic pesticides in a commercial almond orchard.

2. To demonstrate and facilitate adoption of integrated pest management monitoring techniques and decision-making processes to growers and pest control advisors.

This report summarizes our progress as we approach the end of the second season of a 4-year project. The trial is being conducted in a 120-acre Nonpareil orchard west of Modesto. Three insect pest management programs are replicated three times within the trial. Each plot is approximately 13.5 acres in size. The treatments are:

Grower's Standard Practice (common in the Northern San Joaquin Valley):

- A dormant application of 8 oz. Asana XL (a pyrethroid), 8 lb. copper (Kocide DF), and 6 gallons of oil (Gavicide 440).
- A May spray of 4 pints Lorsban 4E (an organophosphate).
- Omite for mite control.
- Lorsban @ 4 pints for ant control if shown necessary through monitoring.

"Soft" Program #1: In these areas, "reduced risk" pesticides are used:

- A dormant application of 6 oz Success® , 8 lb. copper (Kocide DF), and 6 gallons of oil.
- A May PTB spray of 6 oz Success®
- Agri-Mek 0.15 EC @ 10 oz & Gavicide 440 oil @ 1 gallon for mite control
- Abamectin bait (Clinch) @ 1.5 pounds for ant control if shown necessary through monitoring.

"Soft" program #2: This program utilizes Bt in lieu of traditional dormant and in-season sprays:

- A dormant application of oil only (Gavicide 440 @ 6 gallons).

- Two spring applications of Bt (Dipel DF @ 1 lb.). These were tank mixed with normally scheduled fungicide and foliar nutrient applications and therefore did not necessitate additional application costs.
- Two May sprays of Bt (Dipel DF @ 1 lb.) timed for 300-350 & 450-500 degree days after biofix of peach twig borer.
- Potassium nitrate & oil for mite control
- Abamectin bait (Clinch) @ 1.5 pounds for ant control if necessary.

Dormant sprays were applied on January 12-13 in 100 gallons of water per acre. Mummies were removed and destroyed in all treatments. Mummy counts averaged 1.9 mummies per tree throughout the trial. This falls just below the established UC threshold of less than two mummies per tree.

We attempted to time the two spring Bt sprays with 20-40% and 80% peach twig borer emergence from their hibernacula. In an attempt to prevent additional application costs and to mimic what most growers do, we applied these sprays with regularly scheduled fungicide and foliar nutrient sprays. Unfortunately, the first spray was probably applied too early at about 5% emergence. The second application went on at about 60-70% emergence. Due to the cold spring, PTB emergence was prolonged. Three Bt applications were probably necessary to adequately cover PTB emergence this year.

Monitoring:

This trial is extensively monitored for peach twig borer, naval orangeworm, web spinning mites, San Jose scale adult males and crawlers, and San Jose scale parasitoids (Encarsia and Aphytis) from March through October. In addition, brown almond mite, European red mite and San Jose scale are monitored in the dormant season. In each treatment replication there are two PTB pheromone traps, two S.J. scale pheromone traps, eight S.J. scale crawler sticky tape traps, and two NOW egg traps for a total of 126 traps in the trial. PTB and NOW traps are checked twice each week. San Jose scale pheromone and sticky tape traps are checked weekly. Beginning in May, plots are monitored weekly for mites using the presence / absence sampling technique. Ants were monitored four times using the hot dog baiting method.

PTB pheromone traps were hung March 16 and checked every other day to establish the first biofix. Biofix for the overwintering generation of PTB was established on March 30. The first naval orangeworm egg was detected on March 20. Trap catches and the degree-day phenology model were used to determine application timings for May PTB sprays.

Cumulative trap catches through October 2, 2000 for PTB, SJS scale males, Encarsia, Aphytis and NOW eggs are listed below for the three treatments.

	Average cumulative number of arthropods per trap through October 2, 2000.				
	PTB	S.J. Scale	Encarsia	Aphytis	NOW
Standard:	1784	57	2103	45	18
Soft #1	1321	274	4365	65	43
Soft #2	1711	114	4180	85	19

As in the first year of the trial, we have seen approximately twice as many Encarsia scale parasitoids in the "soft" programs verses the program with the dormant pyrethroid treatment. Male San Jose scale adult numbers are very low in all treatments. In Stanislaus County, it is rare to find an orchard with a San Jose scale problem due to the high parasitoid populations in the area. Time will tell if the higher scale parasite numbers in the "soft" treatments will keep the San Jose scale under control as well or better than the grower's standard practice.

PTB pressure has been moderate in this orchard this season. It does not appear that there will be significant differences in peach twig borer populations between treatments. Naval orangeworm egg laying was low through the season and there will be no differences between treatments.

Mites:

Beginning May 4, mites have been monitored weekly using the presence / absence sampling method. When using the presence / absence method, leaves are examined for the presence of mites and mite eggs. If a leaf has one or more mites or mite eggs, it is rated as a (+). If no mites or eggs are present, then it is given a (–) rating. Mite predators are also noted. If mite predators are not present, a treatment threshold is reached if approximately 1/3 of examined leaves have mites or eggs. If predators are present, then the treatment threshold is increased to approximately 50% or more of sampled leaves with mites or eggs.

In this trial, ten leaves from ten trees per plot (100 leaves total) are sampled and examined for mites. Past trials have shown mites often build in areas treated with pyrethroids. Although spider mite numbers were greater in the pyrethroid treatment early in the season, mite numbers became similar between treatments by June. In general, spider mite populations remained fairly low in all treatments through the season. Hot spots of brown almond mite appeared in one block but were not related to treatment.

	Percent Leaves with Web Spinning (spider) Mites		
Sampling Date	**Standard**	**Intermediate**	**Soft**
May 4	12.3%	6.7%	3.0%
May 18	6.1	3.9	2.2
May 26	12.2	3.3	8.3
June 1	1.1	1.1	2.8
June 9	3.3	6.1	3.9
June 15	0.6	0.6	2.2
June 22	0.6	0.6	1.1
Average	***5.2***	***3.2***	***3.4***

Agrimek was applied on June 12 to all three reps of Soft treatment #1. Agrimek must be applied while leaves are still soft to maximize absorption and residual effectiveness. Unfortunately this means the material is often applied unnecessarily. Omite was applied to hot spots in the standard practice treatment in early August. Although mite populations were not at treatable levels, Omite has a thirty-day pre-harvest interval and had to be applied as an insurance spray. Spider mite hot spots were treated with potassium nitrate and oil as they became evident in soft treatment #2.

Harvest Reject Levels

At harvest, 1000 almonds were randomly collected from each replication (300 per treatment) and examined for insect damage. Reject levels for all treatments were very low. There were no differences between treatments in percent damage due to NOW, PTB, or ants.

Percent Rejects of Harvested Nonpareil Almonds Farmed Under Three Pest Management Programs.

Stanislaus County Almond PMA Trial, 2000

Treatment	% NOW	%PTB	% Ant	% Gum	Total % Rejects
Standard	0.4	0.4	0.1	0.1	1.0
Soft #1	0.3	0.6	0.03	0.1	1.0
Soft #2	0.3	0.5	0.1	0.4	1.3

Costs Associated with Three Pest Management Programs

Stanislaus County Almond PMA Trial, 2000

TREATMENT	APPLICATION		COST PER PLOT ACRE
Grower's Practice (RED)	**Dormant Spray (1-12-00)**	Asana XL @ 8 oz	$8.78
		Kocide DF @ 8 lb.	$18.76
		Gavicide Super 90 @ 6 gal	$16.47
		Application costs:	$13.65
		Subtotal:	**$57.66**
	May Spray (5-8-00)	Lorsban 4E @ 4 pints	$23.95
		Nu-Film 17 @ 12.8 oz	$3.40
		Application costs:	$13.65
		Subtotal:	**$41.00**
	Mite Spray	Omite 6E @ 3 pints	$6.32
		(spot sprays to 5.8 acres (15% of plot acreage)	$2.00

	(7-26-00)	acreage) Application costs Subtotal	**$8.32**
		TOTAL PROGRAM COSTS	**$<u>106.98</u>**
"Reduced Risk" Pesticides **(WHITE)**	**Dormant Spray** **(2-1-00)**	Success @ 6 oz Kocide DF @ 8 lb. Gavicide Super 90 @ 6 gal Application costs Subtotal	$35.21 $18.76 $16.47 $13.65 **$84.09**
	May Spray **(5-9-00)**	Success @ 6 oz Application costs Subtotal	$35.18 $13.65 **$48.83**
	Mite Spray **(6-12-00)**	Agrimek @ 10 oz Super 90 oil @ 1.5 gal Application costs Subtotal	$65.56 $4.12 $13.65 **$83.33**
		TOTAL PROGRAM COSTS	**$<u>216.25</u>**
"Soft" Program **(BLUE)**	**Dormant Spray** **(2-1-00)**	Gavicide Super 90 @ 6 gal Application costs Subtotal	$16.47 $13.65 **$30.12**
	Bloom-time PTB Sprays (piggy-backed with fungicides)	Dipel DF @ 1 lb. (3-1-00) Application costs Dipel DF @ 1 lb. (3-17-00) Application costs Subtotal	$10.47 $0.00 $10.47 $0.00 **$20.94**
	May PTB Sprays	Dipel DF @ 1 lb. (5-3-00) Nu-Film P @ 6 oz Application costs Identical second application (5-12-00) Subtotal	$10.47 $1.33 $13.65 $25.45 **$50.90**
	Spot Mite Sprays	Potassium nitrate @ 10 lb / 100 applied @ 200 gpa	$1.50 $2.11

	6-12-00 – 7% of area **8-2-00 – 19% of area**	Super 90 oil @ 1.5 gal / 100 applied @ 200 gpa Application costs Subtotal	$3.50 **$7.11**
		TOTAL PROGRAM COSTS	**$109.07**

Conclusions:

After two years of intensive monitoring, we have not seen an increase in any pest in the "soft" treatments compared to the standard grower's practices. There also have not been any differences in rejects due to PTB or NOW at harvest. It is clear San Jose scale parasitoids are significantly reduced in areas where a pyrethroid is applied in the dormant period and an organophosphate is applied in-season. In Stanislaus County, almond and stonefruit orchards rarely have significant damage from San Jose scale whether orchards are treated with insecticides or not. However, in areas where San Jose scale is a serious threat, growers should understand that the use of some insecticides could exacerbate their scale problems.

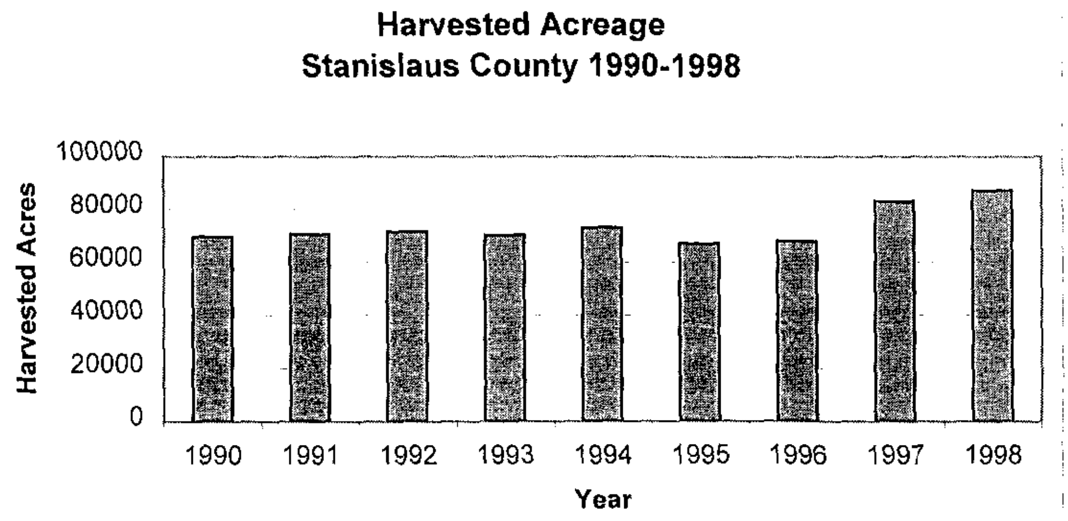
The cost of the Bt program is almost identical to the grower's standard pesticide program. This includes the cost of two May sprays of Bt. No additional application costs are incurred during the bloom sprays if Bt can be applied with regularly scheduled fungicide or nutrient sprays. If Bt timing does not correspond well with other sprays or a third application is necessary, cost of the Bt program could be slightly higher than the standard program. However, if pyrethroid or organophosphate sprays facilitate the need of a mite spray, then a Bt program could prove more cost effective. The intermediate treatment is twice as expensive as the other two programs. The costs of Success and Agrimek far exceed their alternatives. In addition, Agrimek must be applied early in the season as a preventative treatment, often leading to unnecessary and expensive applications.

One should use caution when interpreting results from this trial. We are only halfway through a four-year study. In addition, this orchard appears to be in an area with fairly low pest pressure. It is possible damage would remain low in this orchard even if it remained completely untreated. A Bt program may prove less satisfactory in an orchard under high PTB pressure.

Stanislaus County Pesticide Summary

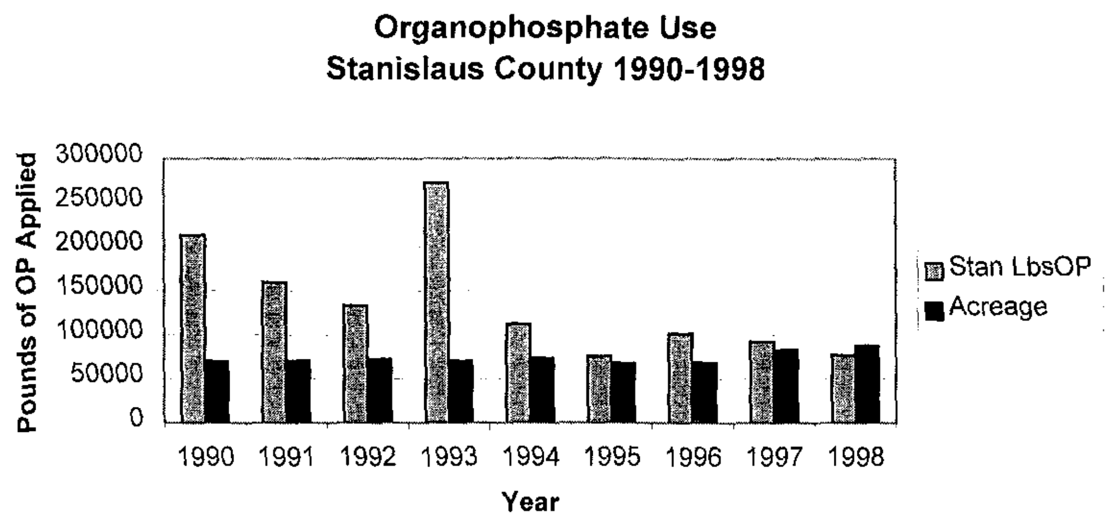
Despite rapid population growth in Stanislaus County throughout the past 10 years, the amount of harvested almond acreage has increased. Chart 4.1 shows the trend of harvested acreage in Stanislaus County.

Chart 4.1. Harvested Acreage in Stanislaus County 1990-1998.



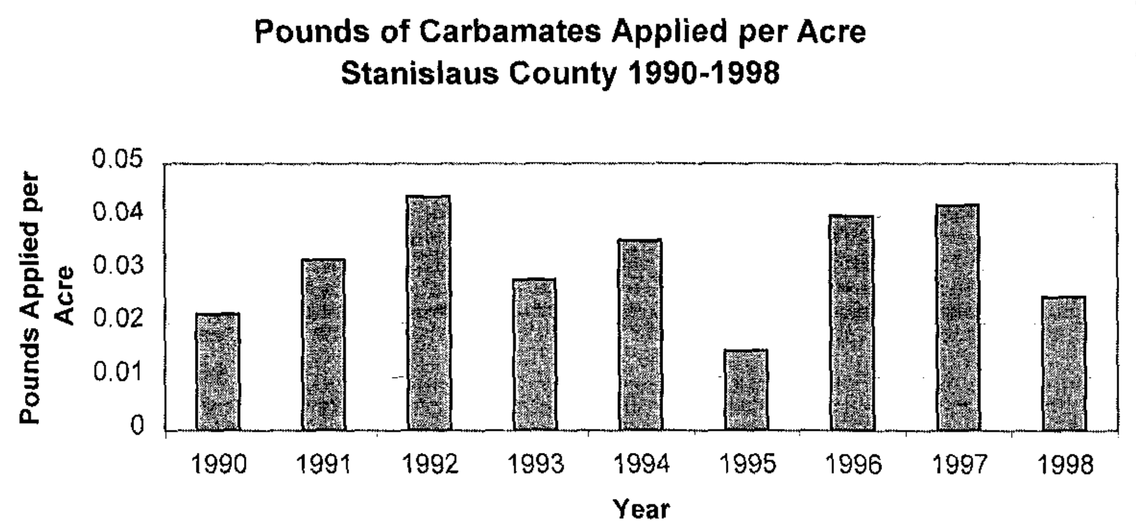
Organophosphate use in Stanislaus County has decreased substantially from 1990 to 1998. From a high pounds applied per acre in 1993, organophosphate use has decreased substantially. As stated above, the information regarding harvest acreage was access from the California Agricultural Statistical Service (CASS) and the pesticide use was accessed via the World Wide Web www.ipm.ucdavis.edu. Chart 4.2 shows the trend of organophosphate use.

Chart 4.2. Organophosphate use in Stanislaus County 1990-1998.



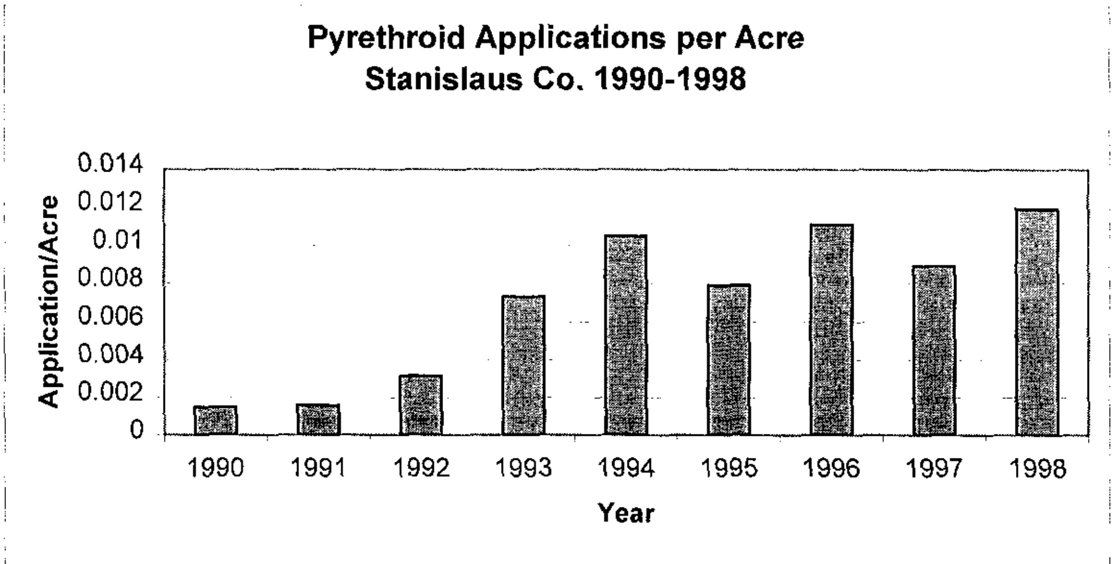
Carbamates applied in Stanislaus County have fluctuated throughout the years but decreased in 1998. Chart 4.3 shows the trend of carbamates in Stanislaus County from 1990-1998.

Chart 4.3. Pounds of Carbamates applied per acre in Stanislaus County 1990-1998.



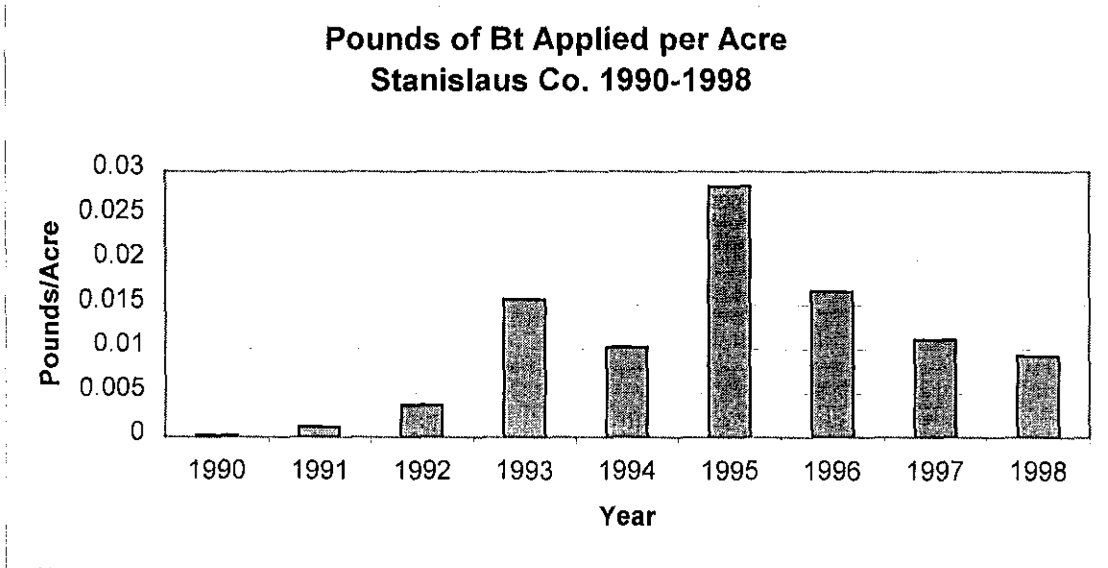
Pyrethroid applications per acre in Stanislaus County have risen since 1992 then the use per acre fluctuates every other year. Chart 4.4 shows the pyrethroid application trend in Stanislaus County.

Chart 4.4. Pyrethroid applications per acre in Stanislaus Co. 1990-1998.



Bt use per acre in Stanislaus County appears to have peaked in 1995 and then has shown a steady decline in use. Chart 4.5 shows the trend of Bt use per acre in Stanislaus County.

Chart 4.5. Bt use per acre in Stanislaus County from 1990-1998.

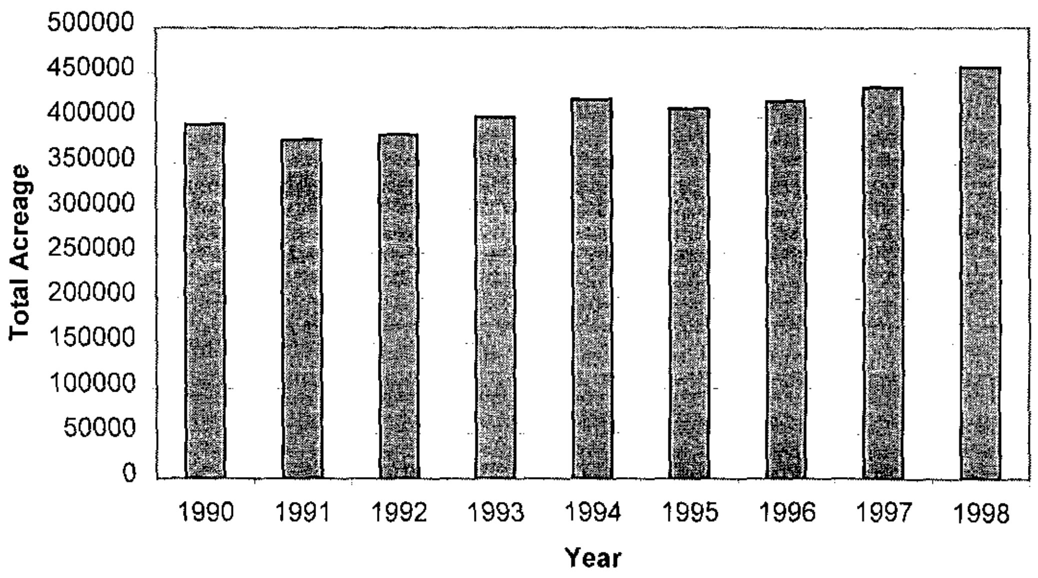


Task 5: Pesticide Use Reports

In a report written for the Almond Board of California by Susan Bassein and Lynn Epstein both from the University of California Davis titled "Reduction in use of organophosphates in Almond Orchards During the Rainy Season in California" shows that the amount of organophosphates are being applied with more discretion today than in the early 1990's. By accessing the Pesticide Use Reports from 1990 to 1997, they have shown a reduction of growers using organophosphate dormant sprays by 31 to 48%, depending on the region. The researchers also show the use of organophosphates applied during the dormant season was reduced 22 to 57% depending on the region. Furthermore, they reported a significant increased use of Bt. This research is based upon the rainy season, a time period where organophosphate dormant sprays are typically applied. **The results are promising, indicating a positive and proactive response the almond industry has adopted in order to curb organophosphate use.**

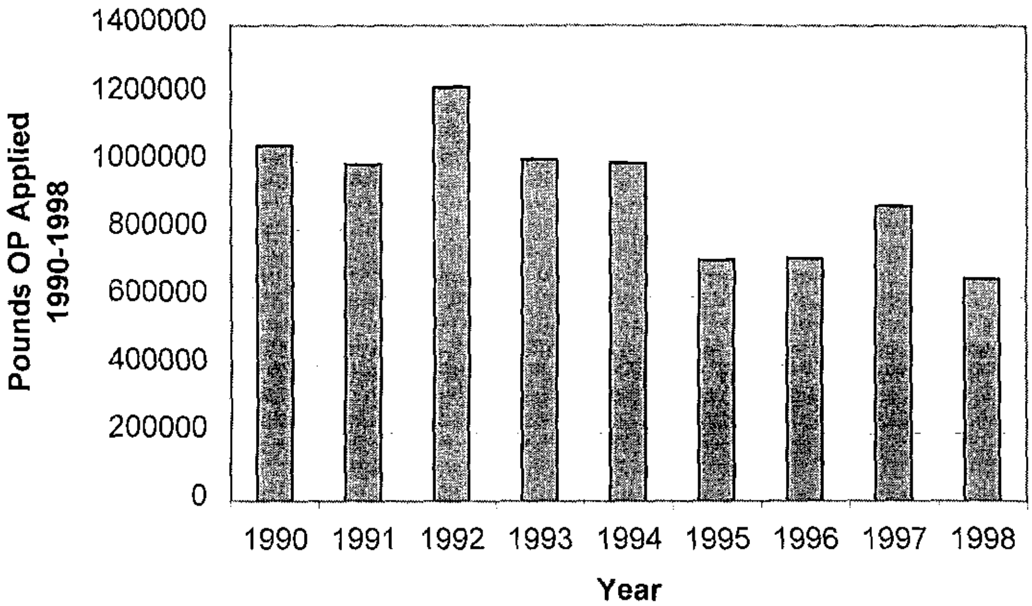
The results reported here are show a similar trend to the report submitted by Bassein and Epstein. With the increasing amount of commercial almond acreage in the 10 counties used in this report, the amount of organophosphates and carbamates applied per acre are decreasing and the use of Bt applied per acre is increasing across the state in commercial almond orchards. Table 5.1 shows the commercial almond acreage in ten counties. Organophosphates, carbamates, pyrethroids, and Bt use were tracked in 10 almond growing counties in California using the Pesticide Use Reports from 1990-1998. The counties included in this report are Butte, Kern, Stanislaus, Colusa, Fresno, Glenn, Madera, Merced, San Joaquin, and Tulare. Pounds or applications per acre are reported since there is a large difference in the amount of acres in each county.

Table 5.1. Almond Acreage in 10 California almond producing counties 1990-1999.



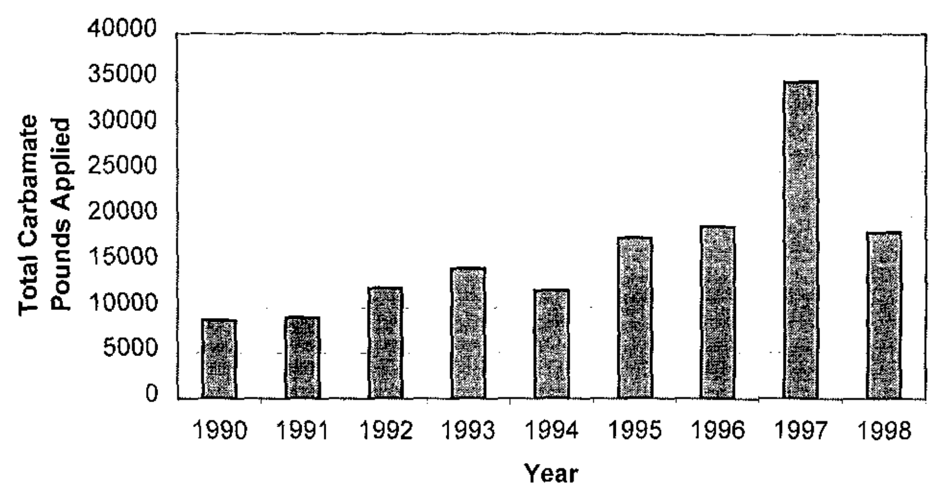
Organophosphates used in these results are: azinphos-methyl, chlorpyrifos, dvvp, diazinon, disulfoton, fenamiphos, malathion, methidathion, naled, parathion, and phosmet. Since each county has various amounts of almond acreage, pounds per acre were analyzed. Table 5.2 depicts the 10 county use of organophosphates from 1990-1998. The use of organophosphates has dropped in this period. A two-way ANOVA for pounds per acre was performed for the year and county. Furthermore, a two-way ANOVA for pounds per acre was performed for the month and county. The results show that there is no difference ($p=0.2$) in OP use throughout the 1990-1998 period, however, there is a decrease in OP use. There is a significant difference in the counties that apply the organophosphates ($p>0.05$). Fresno and Kern counties have applied the most OP's throughout the 9-year period, averaging 0.3 pounds per acre in each county. The two counties using the least amount of OP's during this 9-year span are Colusa and Glenn counties. There is also a significant difference in the time of year the organophosphates are being applied ($p>0.05$). As expected, the heavy organophosphate use occurs in January and July. This corresponds to dormant and hullsplit sprays.

Table 5.2. Organophosphate use from 1990-1998 in California almonds.



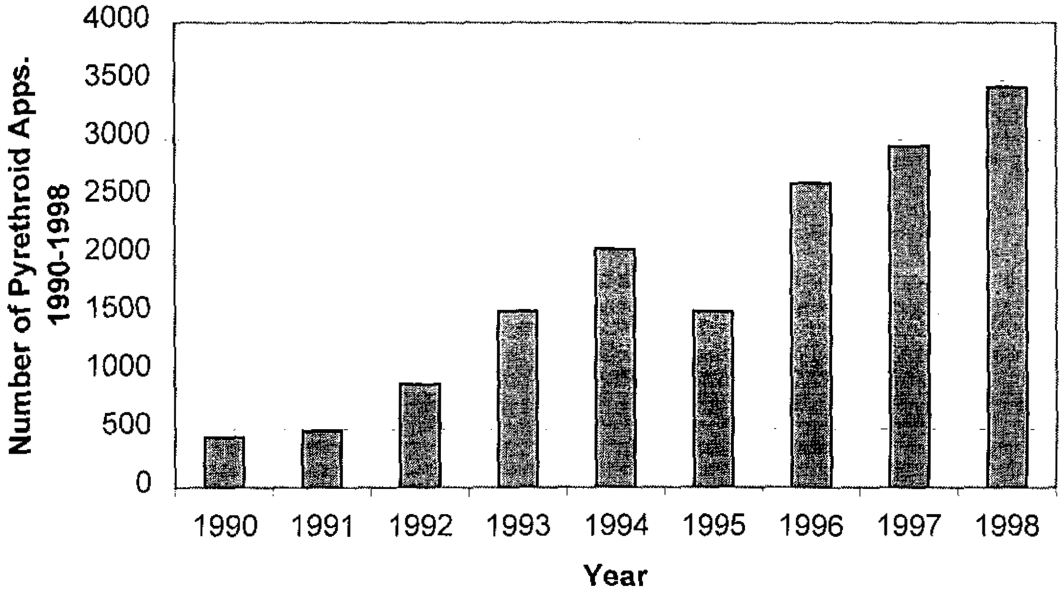
Carbamates used in these results are methomyl and carbaryl. The use of carbamates has not altered significantly in the past 9 years ($p=0.59$) despite the spike in 1997 (Table 5.3). However, counties do apply carbamates significantly differently ($p<0.05$). Kern and San Joaquin counties apply significantly more carbamates per acre than any of the other counties in this study. Similar to organophosphate use, there is a significant difference in the month which carbamates are applied. January and July have significantly more carbamate applications than any other month. Again, these two months correspond to dormant and hullsplit sprays.

Table 5.3. Pounds of Carbamate Applied in 10 California Almond Producing Counties 1990-1998.



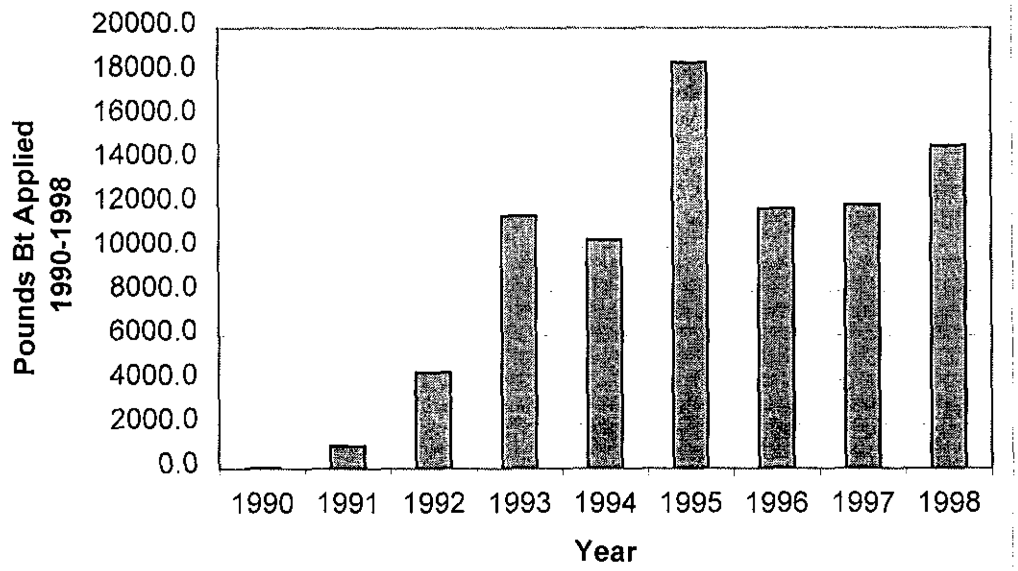
Pyrethroids were calculated according to application numbers. The application numbers from 1990-1998 have significantly increased ($p<0.05$) and are shown on Table 5.4. Fresno, San Joaquin, and Stanislaus counties significantly have the most applications of pyrethroids than the other counties in this report ($p<0.05$).

Table 5.4. Pyrethroid applications in 10 California Almond Producing Counties 1990-1998.



There has been a significant increase in the use of Bt in commercial almonds ($p<0.05$). The pounds of Bt applied per acre has risen steadily since 1990 when virtually no Bt was applied statewide. Madera and Merced counties apply the most pounds per acre, followed by Fresno and Kern counties. San Joaquin county applies the least amount of Bt ($p<0.05$). There is also a significant difference in the month in which Bt is applied ($p<0.05$). Bt is applied most in February and March. Bt use spikes again in July but is not significant.

Table 5.5. Pounds Bt applied in 10 California Almond Producing Counties 1990-1998.



Task 6: Outreach and Extension

Outreach and the extension of information are paramount in gaining confidence in reduced risk practices. Conducting Advisory Team meetings, field meetings, and providing information via newsletters, status reports, and articles play an important role.. In a survey conducted by BIOS, taken after the Hamilton City meeting in November, 2000, 39% of the growers participating in the survey learned of the meeting through a Farm Advisor. This shows the importance of the Farm Advisor in outreach activities. Approximately 35% of the growers learned of the meeting through the Almond Board PMA Newsletter and approximately 20% learned of the meeting via some other media.

Attendance at field day meetings reflects the optimism and success the PMA program. Each region organizes two meetings per year. One meeting is conducted in the spring and the other is a dormant/winter meeting. The listing of these meetings are seen below in Table 6.1. These meetings coincide with the time of the season where many insecticidal sprays are being applied and therefore are relevant for discussing reduced risk practices for controlling pests.

Table 6.1. Field Day and Attendance Almond PMA 2000.

Field Day	Date	Attendance
Southern San Joaquin Valley Spring Meeting	May 9, 2000	80
Sacramento Valley Field Meeting	May 24, 2000	100
Spring Almond PMA Field Meeting – Stanislaus Co.	May 19, 2000	130
Dormant Meeting – Sutter/Yuba/Colusa Cos.	November 14, 2000	30
Dormant Meeting – Butte/Glenn/Tehama Cos.	November 17, 2000	60
Dormant Field Meeting – Madera Co.	December 14, 2000	50
Dormant Field Meeting – Kern Co.	November 22, 2000	50

In addition to the meeting, growers are encouraged to participate in a PMA Field Day Evaluation designed by BIOS. At the Hamilton City dormant meeting, most of the growers attending found the information to be helpful and applicable in their orchards. Overall, the growers found that the meeting length provided enough time for discussion and there was enough of hands-on participation. These surveys provide the PMA with useful information in order to be able to provide growers with information they feel will encourage them in adopting reduced risk practices.

Newsletters are an important component for relaying updates and informing growers, some who may not be active in the PMA, on issues regarding almonds in California. Many of these newsletters are regional, thereby relaying pertinent information to growers. Some newsletters are sent via mail, others are status reports or quarterly reports reported by the Almond PMA to the Department of Pesticide Regulation that can be accessed via the World Wide Web. Listed below in Table 6.2, are newsletters, status reports, and quarterly reports written by the Almond PMA project and submitted to the Department of Pesticide Regulation. Those reports accessed electronically can be reached at: www.lookercomm.com/AlmondPMA/almondPMA.htm

Table 6.2. Newsletters regarding Almond PMA 2000.

Name of Newsletter	**Date of Newsletter**	**How information reached target**
Almond Board of CA Dormant Spray Newsletter	Winter 1999	Mailing/Online
Almond PMA Newsletter	Fall 2000	Mailing/Online
Quarterly Reports	Feb., May, Aug., 2000	Online
Butte Co. Status Reports	Jan., April, May, Oct., 2000	Online
Kern Co. Status Reports	Jan., Feb., April, Oct., 2000	Online

Stanislaus Co. Status Reports	April, May, Oct., 2000	Online

News articles and news coverage relating to the Almond Pest Management Alliance benefit the program by reaching a large audience in popular agricultural periodicals.

Many growers and those involved with the almond industry subscribe to or have access to agricultural periodicals. The Almond PMA makes good use of this medium for educating and updating many of those growers who do not actively participate in the Almond PMA. Through this medium, as seen in Table 6.3, we hope to spark interest in the program, thereby increasing the numbers of growers voluntarily adopting reduced risk techniques in some capacity.

Table 6.3. Publication relating to the Almond PMA Project 2000.

Publication/Name of Article	**Date Released**	**Medium of Release**
The Search for OP Alternatives	April 2000	California Farmer
Reduced Risk Pest Control	May 2000	Agex.com
Kern Co. "Hooked on Poison"	May 2000	PAN Report - Bakersfield
Almond PMA – 3 rd Year Funding	June 2000	Chip Power – Californian staff writer
Press Releases for Dormant Field Days	2 weeks before event	Email
Press Releases for Spring Field Days	2 weeks before event	Email

DISCUSSION

The second year of the Almond Pest Management Alliance has clearly shown that the Almond PMA continues to be an effective program for growers and Pest Control Advisors who are interested in learning about reduced risk systems. The impending loss of traditional crop protection tools due to FQPA implementation, the possible risks to water quality from some dormant sprays, and a renewed interest in farming with more sustainable practices all indicate that the PMA project is important to almond growers.

The Almond PMA in its first year demonstrated the power of pooling resources to educate growers about reduced risk approaches. By working together, the various partners were able to reach more growers and Pest Control Advisors than any one individual organization could have reached on its own. UC farm advisors were able to have their limited resources expanded by the talents offered by PMA partners, whether it is in mailing out field day flyers, staffing sign-in booths, arranging for field day lunches or paying the salaries of field scouts who do the critical monitoring work.

The Almond PMA in its second year built upon the alliance formed from the various partners involved. The management team continues to discuss and be proactive in the goal for reducing pesticide use in almonds. Each of the original regional demonstration orchards remained in the program demonstrating that growers are committed to reducing pesticide use. Each of the regional orchards kept the same overall program including some additions, which made the program better. For statistical purposes, the trapping performed in each region remained similar.

By speaking with one voice on the critical issue of pesticide use, the Almond PMA has done much during the past two years to raise interest in reduced risk farming practices among growers.

The collective voice has also been valuable in helping educate governmental regulatory agencies regarding the many complex issues involved in almond production. The PMA has proven to be a valuable platform from which the industry can educate such agencies as the Environmental Protection Agency, the State Water Resources Control Board, the regional Water Quality Control Boards, and the California Department of Pesticide Regulation pertaining to almond production practices and the importance of controlling pests and diseases.

Specifically, the Almond PMA was an important topic during an October, 2000 tour of the almond growing region by high-ranking EPA officials to learn more about reduced-risk farming scenarios.

Further, the Almond PMA was highlighted in a high-profile Sacramento River watershed project document wherein voluntary programs to reduce pesticide runoff were discussed.

SUMMARY AND CONCLUSIONS

The Almond PMA benefits the almond industry, the University, the almond grower, and the environment. Through this program there exists a cooperative of group of industry leaders, a baseline of pest population in each region has been established, growers and PCA's are being educated about reduced risk practices, and economic data relating to conventional versus reduced risk practices has been analyzed.

A continuing benefit is the interactions of the PMA Advisory Team. The Team develops the program, sponsors meetings and attends field meetings. The diversity of the team allows for developing the best program possible. The team members also refer to the Almond PMA in the course of their other responsibilities, thereby increasing the visibility of the PMA.

A historical account of pest populations in each of the three regions is a very useful component of the Almond PMA. Continuing to monitor and track pests over many growing seasons in the same region provides important information as to the pest population and assists in the interpretation of conventional versus reduced risk control measures.

Growers have been eager to learn at the field meetings and have turned out in great numbers. These meetings provide useful information regarding farming issues with an emphasis on reduced risk techniques. Given the number of growers consistently attending these meetings, it is evident that growers are interested in reduced risk practices. At the dormant meeting held in Hamilton City, Glenn County, many of the growers brought in dormant samples to be viewed and learned to distinguish between pests. Growers collected samples from various varieties in order to determine if one variety was prone to more damage. This enthusiasm, sharing of information and interaction is evident in each region.

This year the focus was to schedule more field meetings in specific locales, allowing for more one-on-one with growers. By addressing localized concerns, implementation of reduced risk techniques in neighboring orchards can be addressed. Since reduced risk is not a 'one size fits all' approach, pest control issues and assistance can be provided to growers willing to adopt reduced risk techniques.

Each regional orchard essentially has three treatments: a pesticide dependent (conventional), a reduced risk, and an intermediate program that implements conventional and reduced risk pesticides. Conventional usually corresponds to the grower standard and includes some organophosphate application. Regional differences do occur. The Butte County conventional does not include an organophosphate application. The reduced risk treatment relies on soft chemicals and the intermediate treatments use a combination of the two previous treatments. The intermediate program will limit pesticide use and still enable the grower to participate and study the effects of reduced risk farming.

Thus far, the Almond PMA has documented that growers are proactive and interested in adopting reduced risk farming practices. Damage levels are acceptable when implementing a reduced risk program on a small but growing amount of acreage in three vastly different almond growing regions.

Obstacles encountered during the second year include:

- Secondary pests pressures. Without the dormant spray, pests not historically found have increased in population, particularly European fruit lecanium in the Butte County orchard and leaffooted bug in the Kern County demonstration site.
- Request for a "no input" plot. This is a delicate subject for many growers and those involved in the PMA project were reluctant to agree to this treatment. However, for Year 3, the PMA will be able to have an untreated treatment in at least one of the three regions.
- Regional differences. Outreach efforts need to be targeted and specialized as the project moves forward in Year Three. Observance of significant regional differences indicate the Almond PMA must continue to address localized concerns and assist growers in adopting reduced risk practices of regional significance.

Lessons learned in Year Two are:

1. Monitoring is key to the success of any pest control program. Considerable funds have been spent by the University of California and the Almond Board of California on the study of pests and diseases. Monitoring data is of little value unless it is implemented in a pest and disease-monitoring program. Using reduced risk methods require well informed, intelligent decisions on how to control diseases and pests.
2. Economic analysis is critical to the success of any reduced risk program. Growers are responsible stewards of the land but cannot continue to farm unless it is an economically sound program. Providing economic information is key to possible future adoption of reduced risk practices.

Overall, the Almond PMA has been successful and is showing great promise for reduced risk farming. The partnership that has been established communicates efficiently together and is successful in its communication and outreach efforts with growers. Almond growers are genuinely interested in the Almond PMA program. By continuing to work on the grass roots level, the Almond PMA continues to address the importance of reduced risk farming.